

Appendix A

Feedstock Composition

Feedstock Composition Data Sheet

Feedstock / Product: Corn Stover

Units: Tons

Source of Base Data: NYS Ag Statistics

Conversion Factor: 2.0 tons/acre

Source of Conv. Factor: NREL 1.8-2.0 dry tons/acre, NYSERDA 2.5 tons/acre

Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	1,208,000	1,080,000	1,180,000	1,220,000	1,260,000	1,300,000
Production within North Country	49,720	40,600	45,800	53,400	53,800	55,000
Production on RCBS Farm Site	1,339	1,286	1,170	1,370	1,420	1,448

Additional Notes:

Assay Information

Source of Data: Stalk Residue Book provided by Raytheon

Source of Additional Data: NREL Feedstock Datasheet

	Raytheon	NREL
Total Solids		
Extractives (water and ethanol soluble)		2.11%
Glucose	38%	45.39%
Xylose	16%	23.86%
Galactose	1%	1.11%
Arabinose	2%	2.00%
Mannose	1%	0.00%
Klason lignin		18.53%
Acid soluble lignin		0.00%
Total ash		7.00%
Mass balance		0.02%
Cellulose	38.4%	
Pentosan	27.6%	
Lignin	34.3%	

Notes:

Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet						
Feedstock / Product: Grass Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: Source of Conv. Factor: Other Info: Hay- other than Alfalfa						
Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	1,848,000	1,890,000	2,132,000	1,758,000	1,740,000	1,720,000
Production within North Country	354,740	369,000	416,200	321,600	325,400	341,500
Production on RCBS Farm Site	750	750	750	750	750	750
Additional Notes:						
Assay Information						
Timothy Hay						
Source of Data: Dr. Lorin Harris, Utah State University (Harris) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)						
		Harris	NRB			
Dry Matter						
Moisture						
Ash		5.8%	6.3%			
Crude Protein		8.5%				
Ether Extract		2.7%	2.6%			
Crude Fiber		33.5%	31.0%			
Nitrogen Free Extract		49.5%				
Neutral Detergent Fiber			67%			
Acid Detergent Fiber			36%			
Cellulose			33%			
Lignin			5.0%			
Brome Hay						
Source of Data: Dr. Lorin Harris, Utah State University (Harris) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)						
		Harris	NRB			
Dry Matter			88%			
Moisture						
Ash		8.6%	9.4%			
Crude Protein		11.8%	16.0%			
Ether Extract		2.6%	2.6%			
Crude Fiber		32.0%	30.0%			
Nitrogen Free Extract		45.0%				
Neutral Detergent Fiber			65%			
Acid Detergent Fiber			35%			
Cellulose			32%			
Lignin			4.0%			
Notes: Composition percentages are based on a 100% dry matter basis.						

Feedstock Composition Data Sheet						
Feedstock / Product: Straw Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: Wheat .9 tons/acre, Oats .7 tons/acre, Rye 1.1/acre, Barley .7/acre Source of Conv. Factor: NYCGA Other Info:						
Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	294,740	273,900	307,800	281,500	278,400	332,100
Production within North Country	2,978				5,880	9,012
Production on RCBS Farm Site	212	272	243	221	189	135
Additional Notes: RCBS- Wheat only Regional data- 1996 and 1997 -Primarily Oats, Quantities of others negligible						
Assay Information						
Barley Straw						
Source of Data: Animal Agriculture by HH Cole (Cole) Location of Sample: Other Information: Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Location of Add. Sample:						
		Cole	NRB			
Dry Matter			91%			
Moisture		10.0%				
Ash		6.0%	7.1%			
Crude Protein		3.7%	4.3%			
Ether Extract		1.6%	1.9%			
Crude Fiber		37.7%	42.0%			
Nitrogen Free Extract		41.0%				
Neutral Detergent Fiber			80%			
Acid Detergent Fiber			59%			
Cellulose			37%			
Lignin			11.0%			
Straw, Assay Information, cont.						
Wheat Straw						
Source of Data: NREL Feedstock Datasheet Location of Sample: Other Information: Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Location of Add. Sample:						
		NREL	NRB			
Dry Matter			89%			
Moisture						
Ash		11%	7.8%			
Crude Protein			3.60%			
Ether Extract			1.80%			
Crude Fiber			41.60%			
Nitrogen Free Extract						
Neutral Detergent Fiber			85%			
Acid Detergent Fiber			54%			
Cellulose			39%			
Klason Lignin		15%	14.0%			
Extractives		13%				
Glucose			37%			
Xylose		24%				
Oat Hay and Oat Straw						
Source of Data: Dr. Lorin Harris, Utah State University (Oat Hay Only) (Harris) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (Oat Straw Only) (NRB)						
		Harris	NRB			
Dry Matter			92%			
Moisture						
Ash		7.5%	7.8%			
Crude Protein		9.2%	4.4%			
Ether Extract		3.1%	2.2%			
Crude Fiber		31.0%	40.5%			
Nitrogen Free Extract		49.2%				
Neutral Detergent Fiber			70%			
Acid Detergent Fiber			47%			
Cellulose			40%			
Lignin			14.0%			
Notes: Composition percentages are based on a 100% dry matter basis.						

Feedstock Composition Data Sheet								
Feedstock / Product: Papermill Waste Units: Wet Tons (approx. 55% moisture content) Source of Base Data: NYSEG report to NYSERDA (1998) Conversion Factor: none Source of Conv. Factor: Other Info:								
Location of Production	5 yr Average	1993	1994	1995	1996	1997		
Statewide Production	643,000	n/a	n/a	n/a	n/a	643,000		
Production within North Country	151,000	n/a	n/a	n/a	n/a	151,000		
Production on RCBS Farm Site	0	n/a	n/a	n/a	n/a	0		
Additional Notes: Data based on single year survey of all 50 mills in NYS. No trend data is available for this feedstock, but paper production has been quite steady. Industrial stoker coal market takes 263,000 tons per year								
Assay Information								
Source of Data: NREL data on waste paper from Fort Howard								
Location of Sample: Fort Howard								
Source of Additional Data: NYSEG study of wastes from two NYS plants / ESF national study								
	Average	St. Dev.						
Total Solids	38.3	0.06						
Extractives (water and ethanol soluble)								
Glucose	22.18	0.57						
Xylose	5.38	0.08						
Galactose	0.11	0						
Arabinose	0.23	0.02						
Mannose	1.49	0.01						
Klason lignin	16.98	0.34						
Acid soluble lignin	0.8	0.01						
Total ash	48.53	0.05						
Mass balance	92.65							
Additional Data								
Sample 1:	As received	Dry basis						
Moisture Content:	55.52%							
Volatile Matter:	31.14%	70.01%						
Fixed Carbon:	0.92%	2.07%						
Ash:	12.42%	27.92%						
Sulfur:	0.04%	0.08%						
BTU/LB:	2154	4343						
Lbs of SO2 per mBTU:		0.33						
Lbs of Sulfur per mBTU:	0.186							
Percent Solids:		44.48%						
Sample 2:	As received	Dry basis						
Moisture Content:	70.02%							
Volatile Matter:	16.32%	54.43%						
Fixed Carbon:	1.36%	4.53%						
Ash:	12.30%	41.04%						
Sulfur:	0.03%	0.08%						
BTU/LB:	1398	4662						
Lbs of SO2 per mBTU:		0.34						
Lbs of Sulfur per mBTU:	0.215							
Percent Solids:		29.98%						
			Ash minerals in Sample 2:					
			Silicon Dioxide 42.64%					
			Aluminium Oxide 30.63%					
			Ferric Oxide 1.31%					
			Titanium Dioxide 0.72%					
			Phosphorus Pentoxide 0.25%					
			Calcium Oxide 20.69%					
			Magnesium Oxide 0.93%					
			Sodium Oxide 0.26%					
			Potassium Oxide 0.19%					
			Sulfur Trioxide 0.80%					
Nationwide Study								
Here is data on analysis of paper mill wastes nationwide. New York has many different types of mills.								
Heat Val MJ/kg	Type of mill	Solids	Ash	C	H	S	O	N
20.1	Bleached Pulp Mill	33.4	1.9	48.7	6.6	0.2	42.4	0.2
21.5	Pulp Mill	42.0	4.9	51.6	5.7	0.9	29.3	0.9
24.1	Kraft Mill	37.6	7.1	55.2	6.4	1.0	26.0	4.4
19.8	Kraft Mill	40.0	8.0	48.0	5.7	0.8	36.3	1.2
12.0	Deinking mill	42.0	20.2	28.8	3.5	0.2	18.8	0.5
12.2	Deinking mill	42.0	14.0	31.1	4.4	0.2	30.1	0.9
20.8	Recycled Mill	45.0	3.0	48.4	6.6	0.2	41.3	0.5
20.6	Recycled Mill	50.5	2.8	48.6	6.4	0.3	41.6	0.4
20.3	Bark	54.0	3.5	48.0	6.0	0.1	42.1	0.3
20.8	Bark	50.0	0.4	50.3	6.2	0.0	43.1	0.0
19.4	Wood chips	79.5	0.2	49.2	6.7	0.2	43.6	0.1
25.0	Wastepaper	92.0	7.0	48.7	7.0	0.1	37.1	0.1
Notes:								

Feedstock Composition Data Sheet

Feedstock / Product: Corn
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	1,859,200	1,587,600	1,916,320	1,793,400	1,887,480	2,111,200
Production within North Country	69,185	56,000	64,980	73,102	74,435	77,409
Production on RCBS Farm Site	1,962	1,800	1,933	1,649	2,219	2,210

Additional Notes:

Assay Information

Source of Data: Animal Agriculture by HH Cole (Cole)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

	Cole	NRB
Dry Matter		77%
Moisture	11.0%	
Ash	1.1%	1.6%
Crude Protein	8.9%	
Ether Extract	3.9%	4.3%
Crude Fiber	2.0%	2.6%
Nitrogen Free Extract	73.1%	
Neutral Detergent Fiber		9%
Acid Detergent Fiber		3%
Cellulose		2%
Lignin		1.0%

Notes:

Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Corn Silage
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	7,779,200	7,810,000	8,216,000	6,790,000	7,905,000	8,175,000
Production within North Country	1,202,420	1,001,000	1,424,100	1,093,900	1,282,000	1,211,100
Production on RCBS Farm Site	1,246	880	1,300	1,050	1,650	1,350

Additional Notes:

Assay Information

Source of Data: Animal Agriculture by HH Cole (Cole)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Cole	NRB
Dry Matter			29%
Moisture		72.1%	
Ash		7.6%	7.2%
Crude Protein		2.3%	8.4%
Ether Extract		0.8%	3.0%
Crude Fiber		7.3%	32.3%
Nitrogen Free Extract		15.7%	
Neutral Detergent Fiber			53%
Acid Detergent Fiber			30%
Cellulose			23%
Lignin			5.0%

Notes:

Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet						
Feedstock / Product: Brewery Waste Units: Tons (dry solids) Source of Base Data: Local news articles on breweries Conversion Factor: 0.33 tons per barrel of beer produced Source of Conv. Factor: United Nations University studies Other Info: Does not include microbrews						
Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	2,901,690	2,778,600	2,828,100	2,877,600	3,014,550	3,009,600
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0
Additional Notes: 3 major breweries in upstate NY (FX Matt, Genesee, Anheuser-Busch) could contribute Info is based on reliable production data. Conversion factor should be reviewed by Raytheon. look for more information . . . DEC permits . . . Etc.						
Assay Information						
Source of Data: Spent grain data from Coors Brewery provided by NREL Location of Sample: Golden CO Source of Additional Data: Research studies						
		Average	St. Dev.			
Total Solids		80.63	0.12			
Extractives (water and ethanol soluble)						
Glucose		27.86	0.05			
Xylose		15.03	0.95			
Galactose		2.33	0.18			
Arabinose		7.12	0.32			
Mannose		0	0			
Klason lignin		35.42	13.23			
Acid soluble lignin		5.06	0.03			
Total ash		4.09	0.25			
Mass balance						
Additional Data						
	Brewers Dried grains percentage	Dried Spent Hops percentage	Grains & 6% Hops			
Moisture	8.00%	8.04%	8.00%			
Protein	25.00%	17.85%	24.57%			
Fat	6.50%	4.90%	6.40%			
Fibre	14.80%	27.77%	15.58%			
Nitrogen Free Extract	42.00%	35.54%	41.61%			
Ash	3.70%	5.90%	3.83%			
Notes:						

Feedstock Composition Data Sheet							
Feedstock / Product: Cheese Whey Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: See Below Source of Conv. Factor: Dave Brown, Cornell Coop. Ext. Other Info:							
Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	219,853		200,588	248,534	208,048	214,726	227,367
Production within North Country							74,179
Production on RCBS Farm Site	0		0	0	0	0	0
Additional Notes: Conversion factors: Cream & Neufchatel: 7.5/lb. to liquid, .065 to dry; Cottage (60% of creamed & lowfat production and curd production): 8.5/lb. to liquid, .065 to dry; All other cheese: 9.0/lb. to liquid, .068 to dry. North Co. 1997 data for St. Law, Jeff, Lewis, Franklin, Clinton, Essex. Data only broken down by Italian and all other cheese w/o cottage. 18324.5 tons calc w/9 lb to liquid, .068 to dry; 129157 calc w/7.5 to liquid, .065 dry.							
Assay Information							
Source of Data: Dr. Lorin Harris, Utah State University (Harris) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Source of WET data: Dairy and Microbiology, E.M. Forster, 1957							
		Harris	NRB				
Dry Matter			93%				
Moisture							
Ash		10.3%	9.8%				
Crude Protein		14.7%	14.2%				
Ether Extract		0.9%	0.7%				
Crude Fiber			0.2%				
Nitrogen Free Extract		74.1%					
Neutral Detergent Fiber							
Acid Detergent Fiber							
Cellulose							
Lignin							
Wet Data							
		Forster					
Moisture		93.0%					
Lactose		4.9%					
Nitrogen Comp		0.9%					
Ash		0.6%					
Fat		0.3%					
Lactic Acid		0.2%					
Notes:							

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Sweet Corn
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.67
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	149,856	168,518	150,717	149,611	138,047	142,388
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Type of Sample: Cob & Husk
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Type of Sample: Process Residue

		ASEB		NRB
		Cob	Husk	Pro. Res.
Dry Matter				32%
Moisture				
Cellulose		32.0%	38.0%	
Hemicellulose		42.0%	44.5%	
Lignin		9.0%	6.6%	
Protein		1.7%	1.9%	7.7%
Ash		1.2%	2.8%	4.9%
Ether Extract				5.2%
Crude Fiber				27%
Acid Detergent Fiber				34%

Notes:

ASEB Composition percentages are based on a 100g of fresh material produced
 NRB Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Cabbage
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.32
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	19,240	23,360	19,488	16,320	14,880	22,154
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Source of Additional Data:

	ASEB
Dry Matter	
Moisture	92.40%
Ash	0.7%
Fat	0.2%
Total Carbohydrates	5.4%
Fiber	0.8%
Protein	1.3%

Notes:

Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Beets
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.41
Source of Conv. Factor: J. Cooper, National Cannery Assn
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	17,045	15,670	18,311	17,589	17,048	16,605
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimental Biology (ASEB)
Source of Additional Data:

	ASEB
Dry Matter	
Moisture	87.30%
Ash	1.1%
Fat	0.1%
Total Carbohydrates	9.9%
Fiber	0.8%
Protein	1.6%

Notes:

Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Snap Beans

Units: Tons Wet Basis

Source of Base Data: NYS Ag Statistics

Conversion Factor: 0.21

Source of Conv. Factor: J. Cooper, National Cannery Assn.

Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	14,281	16,279	14,847	16,134	12,789	11,357
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimental Biology (ASEB)

Source of Additional Data:

	ASEB
Dry Matter	
Moisture	91.00%
Ash	2.0%
Fat	0.3%
Total Carbohydrates	4.6%
Fiber	1.3%
Protein	2.2%

Notes:

Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Grape Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.2
Source of Conv. Factor: J. Cooper, National Cannery Assn.
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	77,195	49,350	69,791	86,177	99,116	81,539
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimental Biology (ASEB)
Type of Sample: Grape Skin
Source of Additional Data:

	ASEB
Dry Matter	
Moisture	81.60%
Ash	0.4%
Fat	1.0%
Total Carbohydrates	15.7%
Fiber	0.6%
Protein	1.3%

Notes:

Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet																																																																
Feedstock / Product: Apple Pomace Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: 10% for Juice/Cider, 30% for Sauce Source of Conv. Factor: J. Cooper, National Canners Assn. Other Info:																																																																
Location of Production	5 yr Average	1993	1994	1995	1996	1997																																																										
Statewide Production	46,132	41,360	45,635	52,875	44,595	46,195																																																										
Production within North Country	0	0	0	0	0	0																																																										
Production on RCBS Farm Site	0	0	0	0	0	0																																																										
Additional Notes:																																																																
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Source of Data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Source of WET data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N)																																																																
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="2" style="text-align: center;">S & N</th> <th rowspan="2" style="text-align: center;">NRB</th> </tr> <tr> <th style="text-align: center;">Low</th> <th style="text-align: center;">High</th> </tr> </thead> <tbody> <tr> <td>Dry Matter</td> <td></td> <td></td> <td style="text-align: center;">89%</td> </tr> <tr> <td>Moisture</td> <td style="text-align: center;">11.0%</td> <td style="text-align: center;">12.5%</td> <td></td> </tr> <tr> <td>Carbohydrates</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Nitrogen free extract</td> <td style="text-align: center;">54.77%</td> <td style="text-align: center;">59.29%</td> <td></td> </tr> <tr> <td>Pectin</td> <td style="text-align: center;">15.00%</td> <td style="text-align: center;">18.00%</td> <td></td> </tr> <tr> <td>Crude fiber</td> <td style="text-align: center;">15.88%</td> <td style="text-align: center;">20.55%</td> <td style="text-align: center;">17.00%</td> </tr> <tr> <td>Proteins</td> <td style="text-align: center;">4.45%</td> <td style="text-align: center;">5.67%</td> <td style="text-align: center;">4.90%</td> </tr> <tr> <td>Fat</td> <td style="text-align: center;">3.75%</td> <td style="text-align: center;">4.65%</td> <td></td> </tr> <tr> <td>Ash</td> <td style="text-align: center;">211.00%</td> <td style="text-align: center;">3.50%</td> <td style="text-align: center;">2.20%</td> </tr> <tr> <td>Potassium (as K2O)</td> <td></td> <td></td> <td style="text-align: center;">0.46%</td> </tr> <tr> <td>Phosphorus (as P2O5)</td> <td></td> <td></td> <td style="text-align: center;">0.11%</td> </tr> <tr> <td>Ether Extract</td> <td></td> <td></td> <td style="text-align: center;">5.10%</td> </tr> <tr> <td>Acid Detergent Fiber</td> <td></td> <td></td> <td style="text-align: center;">26%</td> </tr> </tbody> </table>								S & N		NRB	Low	High	Dry Matter			89%	Moisture	11.0%	12.5%		Carbohydrates				Nitrogen free extract	54.77%	59.29%		Pectin	15.00%	18.00%		Crude fiber	15.88%	20.55%	17.00%	Proteins	4.45%	5.67%	4.90%	Fat	3.75%	4.65%		Ash	211.00%	3.50%	2.20%	Potassium (as K2O)			0.46%	Phosphorus (as P2O5)			0.11%	Ether Extract			5.10%	Acid Detergent Fiber			26%
	S & N		NRB																																																													
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Dry Matter			89%																																																													
Moisture	11.0%	12.5%																																																														
Carbohydrates																																																																
Nitrogen free extract	54.77%	59.29%																																																														
Pectin	15.00%	18.00%																																																														
Crude fiber	15.88%	20.55%	17.00%																																																													
Proteins	4.45%	5.67%	4.90%																																																													
Fat	3.75%	4.65%																																																														
Ash	211.00%	3.50%	2.20%																																																													
Potassium (as K2O)			0.46%																																																													
Phosphorus (as P2O5)			0.11%																																																													
Ether Extract			5.10%																																																													
Acid Detergent Fiber			26%																																																													
Wet Data																																																																
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Feedstock Composition Data Sheet

Feedstock / Product: Waste from Carrots

Units: Tons Wet Basis

Source of Base Data: NYS Ag Statistics

Conversion Factor: 0.48

Source of Conv. Factor: J. Cooper, National Cannery Assn.

Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	8,218	12,240	7,392	7,968	6,768	6,720
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimental Biology (ASEB)

Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

	ASEB	NRB
Dry Matter		12%
Moisture	88.0%	
Ash	0.8%	8.2%
Fat	0.2%	
Total Carbohydrate	9.7%	
Crude Protein	1.1%	9.9%
Ether Extract		1.3%
Crude Fiber	1.0%	9.7%
Nitrogen Free Extract		
Neutral Detergent Fiber		9%
Acid Detergent Fiber		8%
Cellulose		7%
Lignin		0.0%

Notes:

ASEB Composition percentages are based on a 100g of fresh material produced

NRB Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Peas

Units: Tons Wet Basis

Source of Base Data: NYS Ag Statistics

Conversion Factor: 0.13

Source of Conv. Factor: J. Cooper, National Cannery Assn

Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	3,767	2,877	3,206	3,927	3,595	5,229
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)

Other Information: per 100g of fresh material produced

Source of Additional Data:

	ASEB
Dry Matter	
Moisture	83.00%
Ash	1.1%
Fat	0.2%
Total Carbohydrates	12.0%
Fiber	1.2%
Protein	3.4%

Notes:

Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Winery Waste (Grape Pomace from wine production)

Units: tons

Source of Base Data: NYS Ag Statistics

Conversion Factor: 23 pounds of pomace is produced for each 100 pounds of wine

Source of Conv. Factor: Gene Pierce, President of Glenora Winery

Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	13,853	10,702	15,036	12,930	20,525	10,074
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Wine data collected per gallon produced. Transferred into ton data based on 180 gallons / ton figure provided by Gene Pierce of Glenora Winery.

32% of wine (and 32% of pomace) is in the Finger Lakes region, the rest near Hudson, Erie, and Long Island.

Assay Information

Source of Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

Source of Additional Data:

	NRB
Dry Matter	91%
Crude Protein	13.0%
Ether Extract	7.9%
Total Ash	10.3%
Crude Fiber	31.9%
Neutral Detergent Fiber	55%
Acid Detergent Fiber	54%
Cellulose	
Lignin	35%

Notes:

Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Cherry Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.15
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	1,283	1,133	1,770	1,485	1,050	975
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data:
Source of Additional Data:

Dry Matter		
Moisture		
Ash		
Fat		
Total Carbohydrates		
Fiber		
Protein		

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Dedicated Feedstock Willow
Units: Dry Tons
Source of Base Data: SUNY ESF
Conversion Factor: 6 dry tons per acre
Source of Conv. Factor: SUNY ESF
Other Info: low production now on test farms only

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	230	0	30	120	372	630
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Willow is well suited for idle lands with lower soil quality than corn acreage.
 Willow is only being tried on test plots. SUNY predicts between 10,000 and 80,000 acres of willow in New York State by 2015 for electricity production.
 Additional willow may be grown for ethanol production. Land availability is being measured by NYSTEC.
 Numbers for 1993-1995 are estimates based on known information about project history

Assay Information

Source of Data: Environmental Science School / NYSEG study of local willows
Location of Sample: Tully test fields

Carbon:	40.38%	Moisture:	10.00%
Hydrogen:	6.23%	Ash:	1.47%
Nitrogen:	0.46%		
Oxygen:	41.40%	Btu/lb (dry):	8392
Sulfur:	0.05%	Btu/lb (wet):	7553

Notes:

Appendix B

Feedstock Cost

Feedstock Composition Data Sheet							
Feedstock / Product: Corn Stover Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: 2.0 tons/acre Source of Conv. Factor: NREL 1.8-2.0 dry tons/acre, NYSEDA 2.5 tons/acre Other Info:							
Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	1,208,000		1,080,000	1,180,000	1,220,000	1,260,000	1,300,000
Production in North Country Region	49,720		40,600	45,800	53,400	53,800	55,000
Production on RCBS Farm Site	1,339		1,286	1,170	1,370	1,420	1,448
Additional Notes:							
Feedstock Costs Market or Disposal Method: Based on sale for ethanol plants - estimated Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars / dry ton delivered (Harlan) / Dollars / dry ton before delivery (other)							
Source of Data	5 yr Average		1993	1994	1995	1996	1997
NREL Harlan Indiana Demo Study	\$32.00		n/a	n/a	n/a	n/a	\$32.00
Other source	\$30.00		n/a	n/a	n/a	n/a	\$30.00
Transportation Method and Cost							
Method to Transport to Plant: Dry feedstock sent by truck							
Basis of Cost Estimate: 35 mile trucking average distance to plant							
Cost to Transport:	\$7.75		per Ton				
Feedstock Composition - Assay Information							
Feedstock / Product: Corn Stover Source of Data: Stalk Residue Book provided by Raytheon Source of Additional Data: NREL Feedstock Datasheet							
			Raytheon	NREL			
Total Solids							
Extractives (water and ethanol soluble)				2.11%			
Glucose		38%	45.39%				
Xylose		16%	23.86%				
Galactose		1%	1.11%				
Arabinose		2%	2.00%				
Mannose		1%	0.00%				
Klason lignin			18.53%				
Acid soluble lignin			0.00%				
Total ash			7.00%				
Mass balance			0.02%				
Cellulose		38.4%					
Pentosan		27.6%					
Lignin		34.3%					
Notes:							
Composition percentages are based on a 100% dry matter basis.							

Feedstock Composition Data Sheet						
Feedstock / Product: Grass Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: Source of Conv. Factor: Other Info: Hay- other than Alfalfa						
Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	1,848,000	1,890,000	2,132,000	1,758,000	1,740,000	1,720,000
Production in North Country Region	354,740	369,000	416,200	321,600	325,400	341,500
Production on RCBS Farm Site	750	750	750	750	750	750
Additional Notes:						
Feedstock Costs						
Market or Disposal Method: Sold Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton						
Source of Data	5 yr Average	1993	1994	1995	1996	1997
NY State Ag Statistics	\$72.90	\$74.50	\$75.00	\$70.00	\$68.00	\$77.00
	\$0.00					
Transportation Method and Cost						
Method to Transport to Plant: Dry feedstock sent by truck						
Basis of Cost Estimate: 35 mile trucking average distance to plant						
Cost to Transport: \$7.75 per Ton						
Feedstock Composition - Assay Information						
Feedstock / Product: Grass						
Timothy Hay						
Source of Data: Dr. Lorin Harris, Utah State University (Harris)						
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)						
		Harris	NRB			
Dry Matter						
Moisture						
Ash		5.8%	6.3%			
Crude Protein		8.5%				
Ether Extract		2.7%	2.6%			
Crude Fiber		33.5%	31.0%			
Nitrogen Free Extract		49.5%				
Neutral Detergent Fiber			67%			
Acid Detergent Fiber			36%			
Cellulose			33%			
Lignin			5.0%			
Brome Hay						
Source of Data: Dr. Lorin Harris, Utah State University (Harris)						
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)						
		Harris	NRB			
Dry Matter			88%			
Moisture						
Ash		8.6%	9.4%			
Crude Protein		11.8%	16.0%			
Ether Extract		2.6%	2.6%			
Crude Fiber		32.0%	30.0%			
Nitrogen Free Extract		45.0%				
Neutral Detergent Fiber			65%			
Acid Detergent Fiber			35%			
Cellulose			32%			
Lignin			4.0%			
Notes:						
Composition percentages are based on a 100% dry matter basis.						

Feedstock Composition Data Sheet							
Feedstock / Product: Straw Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: Wheat .9 tons/acre, Oats .7 tons/acre, Rye 1.1/acre, Barley .7/acre Source of Conv. Factor: NYCGA Other Info:							
Location of Production	Average	1993	1994	1995	1996	1997	
Statewide Production	294,740	273,900	307,600	281,500	278,400	332,100	
Production in North Country Region	7,446	n/a	n/a	n/a	5,880	9,012	
Production on RCBS Farm Site	212	272	243	221	189	135	
Additional Notes: RCBS- Wheat only Regional data- 1996 and 1997 -North Country data primarily Oats, Quantities of others negligible Regional data from 1996 in the Finger Lakes and Central Regions are estimates for Rye and Barley based on 97.							
Feedstock Costs							
Market or Disposal Method: Sold Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton							
Source of Data	5 yr Average	1993	1994	1995	1996	1997	
Robbins Corn and Bulk Service	\$60.00	n/a	n/a	n/a	n/a	\$60.00	
	\$0.00						
Transportation Method and Cost							
Method to Transport to Plant: Dry feedstock sent by truck Basis of Cost Estimate: 35 mile trucking average distance to plant Cost to Transport: \$7.75 per Ton							
Feedstock Composition - Assay Information							
Feedstock / Product: Straw							
Barley Straw							
Source of Data: Animal Agriculture by HH Cole (Cole) Location of Sample: Other Information: Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Location of Add. Sample:							
		Cole	NRB				
Dry Matter			91%				
Moisture		10.0%					
Ash		6.0%	7.1%				
Crude Protein		3.7%	4.3%				
Ether Extract		1.6%	1.9%				
Crude Fiber		37.7%	42.0%				
Nitrogen Free Extract		41.0%					
Neutral Detergent Fiber			80%				
Acid Detergent Fiber			59%				
Cellulose			37%				
Lignin			11.0%				
Wheat Straw							
Source of Data: NREL Feedstock Datasheet Location of Sample: Other Information: Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Location of Add. Sample:							
		NREL	NRB				
Dry Matter			89%				
Moisture							
Ash		11%	7.8%				
Crude Protein			3.60%				
Ether Extract			1.80%				
Crude Fiber			41.60%				
Nitrogen Free Extract							
Neutral Detergent Fiber			85%				
Acid Detergent Fiber			54%				
Cellulose			39%				
Klason Lignin		15%	14.0%				
Extractives			13%				
Glucose			37%				
Xylose			24%				
Oat Hay and Oat Straw							
Source of Data: Dr. Lorin Harris, Utah State University (Oat Hay Only) (Harris) Source of Additional Data: Nutrient Req. of Beef Cattle, Natl Research Board (Oat Straw Only) (NRB)							
		Harris	NRB				
Dry Matter			92%				
Moisture							
Ash		7.5%	7.8%				
Crude Protein		9.2%	4.4%				
Ether Extract		3.1%	2.2%				
Crude Fiber		31.0%	40.5%				
Nitrogen Free Extract		49.2%					
Neutral Detergent Fiber			70%				
Acid Detergent Fiber			47%				
Cellulose			40%				
Lignin			14.0%				
Notes: Composition percentages are based on a 100% dry matter basis.							

Feedstock Composition Data Sheet								
Feedstock / Product: Papermill Waste Units: Wet Tons (approx. 55% moisture content) Source of Base Data: NYSEG report to NYSEDA (1998) Conversion Factor: none Source of Conv. Factor: Other Info:								
Location of Production	Average	1993	1994	1995	1996	1997		
Statewide Production	643,000	n/a	n/a	n/a	n/a	643,000		
Production in North Country Region	151,000	n/a	n/a	n/a	n/a	151,000		
Production on RCBS Farm Site	0	n/a	n/a	n/a	n/a	0		
Additional Notes: Data based on single year survey of all 50 mills in NYS. No trend data is available for this feedstock, but paper production has been quite steady. Industrial stoker coal market takes 263,000 tons per year								
Feedstock Costs								
Market or Disposal Method: Sent to landfill or other interested buyers Additional Market or Method: Paper companies will pay \$21 per ton to have this removed Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton								
Source of Data	5 yr Average	1993	1994	1995	1996	1997		
NYSEG Study	-\$21.00	n/a	n/a	n/a	n/a	-\$21.00		
	\$0.00							
Transportation Method and Cost								
Method to Transport to Plant: Dry feedstock sent by truck								
Base of Cost Estimate: 35 mile trucking average distance to plant								
Cost to Transport: \$7.75 per Ton								
Feedstock Composition - Assay Information								
Feedstock / Product: Papermill Waste Source of Data: NREL data on waste paper from Fort Howard Location of Sample: Fort Howard Source of Additional Data: NYSEG study of wastes from two NYS plants / ESF national study								
	Average	St. Dev.						
Total Solids	38.3	0.06						
Extractives (water and ethanol soluble)								
Glucose	22.18	0.57						
Xylose	5.38	0.08						
Galactose	0.11	0						
Arabinose	0.23	0.02						
Mannose	1.49	0.01						
Klason lignin	16.96	0.34						
Acid soluble lignin	0.8	0.01						
Total ash	48.53	0.05						
Mass balance	92.65							
Additional Data								
Sample 1:	As received	Dry basis						
Moisture Content:	55.52%	70.01%						
Volatile Matter:	31.14%	2.07%						
Fixed Carbon:	0.92%	27.92%						
Ash:	12.42%	0.08%						
Sulfur:	0.04%	4343						
BTU/LB:	2154	0.33						
Lbs of SO2 per mBTU:	0.186	44.48%						
Lbs of Sulfur per mBTU:								
Percent Solids:								
Sample 2:	As received	Dry basis						
Moisture Content:	70.02%	54.43%						
Volatile Matter:	16.32%	4.53%						
Fixed Carbon:	1.36%	41.04%						
Ash:	12.30%	0.08%						
Sulfur:	0.03%	4662						
BTU/LB:	1398	0.34						
Lbs of SO2 per mBTU:	0.215	29.98%						
Lbs of Sulfur per mBTU:								
Percent Solids:								
			Ash minerals in Sample 2:					
			Silicon Dioxide 42.64%					
			Aluminum Oxide 30.63%					
			Ferric Oxide 1.31%					
			Titanium Dioxide 0.72%					
			Phosphorus Pentoxide 0.25%					
			Calcium Oxide 20.69%					
			Magnesium Oxide 0.93%					
			Sodium Oxide 0.26%					
			Potassium Oxide 0.19%					
			Sulfur Trioxide 0.80%					
Nationwide Study								
Here is data on analysis of paper mill wastes nationwide. New York has many different types of mills.								
Heat Val M.J/kg	Type of mill	Solids	Ash	C	H	S	O	N
20.1	Bleached Pulp Mill	33.4	1.9	48.7	6.6	0.2	42.4	0.2
21.5	Pulp Mill	42.0	4.9	51.6	5.7	0.9	29.3	0.9
24.1	Kraft Mill	37.6	7.1	55.2	6.4	1.0	26.0	4.4
19.8	Kraft Mill	40.0	8.0	48.0	5.7	0.8	36.3	1.2
12.0	Deinking mill	42.0	20.2	28.8	3.5	0.2	18.8	0.5
20.8	Deinking mill	42.0	14.0	31.1	4.4	0.2	30.1	0.9
20.6	Recycled Mill	45.0	3.0	48.4	6.6	0.2	41.3	0.5
20.3	Recycled Mill	50.5	2.8	48.6	6.4	0.3	41.6	0.4
20.3	Bark	54.0	3.5	48.0	6.0	0.1	42.1	0.3
20.8	Bark	50.0	0.4	50.3	6.2	0.0	43.1	0.0
19.4	Wood chips	79.5	0.2	49.2	6.7	0.2	43.6	0.1
25.0	Wastepaper	92.0	7.0	48.7	7.0	0.1	37.1	0.1
Notes:								

Feedstock Composition Data Sheet							
Feedstock / Product: Corn Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: Source of Conv. Factor: Other Info:							
Location of Production	Average	1993	1994	1995	1996	1997	
Statewide Production	1,859,200	1,587,600	1,916,320	1,793,400	1,887,480	2,111,200	
Production in North Country Region	69,185	56,000	64,980	73,102	74,435	77,409	
Production on RCBS Farm Site	1,962	1,800	1,933	1,649	2,219	2,210	
Additional Notes:							
Feedstock Costs							
Market or Disposal Method: Market sales Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per bushel							
Source of Data	5 yr Average	1993	1994	1995	1996	1997	
NY State Ag Statistics	\$3.06	\$2.85	\$2.65	\$3.85	\$2.98	\$2.95	
	\$0.00						
Transportation Method and Cost							
Method to Transport to Plant: Dry feedstock sent by truck							
Basis of Cost Estimate: 35 mile trucking average distance to plant							
Cost to Transport: \$7.75 per Ton							
Feedstock Composition - Assay Information							
Feedstock / Product: Corn Source of Data: Animal Agriculture by HH Cole (Cole) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)							
		Cole	NRB				
Dry Matter			77%				
Moisture		11.0%					
Ash		1.1%	1.6%				
Crude Protein		8.9%					
Ether Extract		3.9%	4.3%				
Crude Fiber		2.0%	2.6%				
Nitrogen Free Extract		73.1%					
Neutral Detergent Fiber			9%				
Acid Detergent Fiber			3%				
Cellulose			2%				
Lignin			1.0%				
Notes:							
Composition percentages are based on a 100% dry matter basis.							

Feedstock Composition Data Sheet							
Feedstock / Product: Corn Silage Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: Source of Conv. Factor: Other Info:							
Location of Production	Average	1993	1994	1995	1996	1997	
Statewide Production	7,779,200	7,810,000	8,216,000	6,790,000	7,905,000	8,175,000	
Production in North Country Region	1,202,420	1,001,000	1,424,100	1,093,900	1,282,000	1,211,100	
Production on RCBS Farm Site	1,246	880	1,300	1,050	1,650	1,350	
Additional Notes:							
Feedstock Costs							
Market or Disposal Method: Market sales Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per ton							
Source of Data	5 yr Average	1993	1994	1995	1996	1997	
NY State Ag Statistics	\$26.30	\$24.10	\$22.70	\$24.50	\$25.80	\$34.40	
	\$0.00						
Transportation Method and Cost							
Method to Transport to Plant: Dry feedstock sent by truck							
Basis of Cost Estimate: 35 mile trucking average distance to plant							
Cost to Transport:	\$7.75	per Ton					
Feedstock Composition - Assay Information							
Feedstock / Product: Corn Silage Source of Data: Animal Agriculture by HH Cole (Cole) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)							
		Cole	NRB				
Dry Matter			29%				
Moisture		72.1%					
Ash		7.6%	7.2%				
Crude Protein		2.3%	8.4%				
Ether Extract		0.8%	3.0%				
Crude Fiber		7.3%	32.3%				
Nitrogen Free Extract		15.7%					
Neutral Detergent Fiber			53%				
Acid Detergent Fiber			30%				
Cellulose			23%				
Lignin			5.0%				
Notes: Composition percentages are based on a 100% dry matter basis.							

Feedstock Composition Data Sheet						
Feedstock / Product: Brewery Waste Units: Tons (dry solids) Source of Base Data: Local news articles on breweries Conversion Factor: 0.33 tons per barrel of beer produced Source of Conv. Factor: United Nations University studies Other Info: Does not include microbrews						
Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	2,901,690	2,778,600	2,828,100	2,877,600	3,014,550	3,009,600
Production in North Country Region	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0
Additional Notes: 3 major breweries in upstate NY (FX Matt, Genesee, Anheuser-Busch) could contribute Info is based on reliable production data. Conversion factor should be reviewed by Technology Provider.						
Feedstock Costs						
Market or Disposal Method: Additional Market or Method: May be given away to farmers (+ transport cost) as feed. Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton						
Source of Data	5 yr Average	1993	1994	1995	1996	1997
Research on breweries	\$0.00	n/a	n/a	n/a	n/a	\$0.00
	\$0.00					
Transportation Method and Cost						
Method to Transport to Plant: Dry feedstock sent by truck						
Basis of Cost Estimate: 35 mile trucking average distance to plant						
Cost to Transport:	\$7.75	per Ton				
Feedstock Composition - Assay Information						
Feedstock / Product: Brewery Waste Source of Data: Spent grain data from Coors Brewery provided by NREL Location of Sample: Golden CO Source of Additional Data: Research studies						
	Average	St. Dev.				
Total Solids	80.63	0.12				
Extractives (water and ethanol soluble)						
Glucose	27.86	0.05				
Xylose	15.03	0.95				
Galactose	2.33	0.18				
Arabinose	7.12	0.32				
Mannose	0	0				
Klason lignin	35.42	13.23				
Acid soluble lignin	5.06	0.03				
Total ash	4.09	0.25				
Mass balance						
Additional Data						
	Brewers Dried grains percentage	Dried Spent Hops percentage	Grains & 6% Hops			
Moisture	8.00%	8.04%	8.00%			
Protein	25.00%	17.85%	24.57%			
Fat	6.50%	4.90%	6.40%			
Fibre	14.80%	27.77%	15.58%			
Nitrogen Free Extract	42.00%	35.54%	41.61%			
Ash	3.70%	5.90%	3.83%			
Notes:						

Feedstock Composition Data Sheet						
Feedstock / Product: Cheese Whey Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: See Below Source of Conv. Factor: Dave Brown, Cornell Coop. Ext. Other Info:						
Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	219,853	200,588	248,534	208,048	214,726	227,367
Production in North Country Region	74,179	n/a	n/a	n/a	n/a	74,179
Production on RCBS Farm Site	0	0	0	0	0	0
Additional Notes: Conversion Factors: Cream & Neufchatel: 7.5/lb. to liquid, .065 to dry; Cottage (60% of creamed & lowfat production and curd production): 8.5/lb. to liquid, .065 to dry; All other cheese: 9.0/lb. to liquid, .068 to dry. Cent/FL/East. 1997 data only broken down by Italian, cottage, and all North Co. 1997 data for St. Law, Jeff, Lewis, Franklin, Clinton, Essex. Data only broken down by Italian and all other cheese w/o cottage. 18324.5 tons calc. w/ 9.0 lb to liquid, .068 to dry. 129157.5 tons calc w/ 7.5 to liquid						
Feedstock Costs						
Market or Disposal Method: Disposed. Companies will pay to have this removed Additional Market or Method: Can be mixed into feed for animals. Delivered free or for small transport fee. Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton						
Source of Data	5 yr Average	1993	1994	1995	1996	1997
Average disposal cost in 1977	-\$5.15	n/a	n/a	n/a	n/a	-\$5.15
Transportation Method and Cost Method to Transport to Plant: Basis of Cost Estimate: Cost to Transport: n/a per Ton						
Feedstock Composition - Assay Information						
Feedstock / Product: Cheese Whey Source of Data: Dr. Lorin Harris, Utah State University (Harris) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Source of WET data: Dairy and Microbiology, E.M. Forster, 1957						
		Harris	NRB			
Dry Matter			93%			
Moisture						
Ash		10.3%	9.8%			
Crude Protein		14.7%	14.2%			
Ether Extract		0.9%	0.7%			
Crude Fiber			0.2%			
Nitrogen Free Extract		74.1%				
Neutral Detergent Fiber						
Acid Detergent Fiber						
Cellulose						
Lignin						
Wet Data						
		Forster				
Moisture		93.0%				
Lactose		4.9%				
Nitrogen Comp		0.9%				
Ash		0.6%				
Fat		0.3%				
Lactic Acid		0.2%				
Notes:						

Feedstock Composition Data Sheet						
Feedstock / Product: Waste from Sweet Corn Units: Tons Wet Basis Source of Base Data: NYS Ag Statistics Conversion Factor: 0.67 Source of Conv. Factor: J. Cooper, National Canners Assn. Other Info:						
Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	149,856	168,518	150,717	149,611	138,047	142,388
Production in North Country Region	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0
Additional Notes:						
Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.						
Feedstock Costs						
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton						
Source of Data	5 yr Average	1993	1994	1995	1996	1997
Processing Plants	-\$60.00	n/a	n/a	n/a	n/a	-\$60.00
Processing Plants	-\$65.00	n/a	n/a	n/a	n/a	-\$65.00
Transportation Method and Cost						
Method to Transport to Plant: Dry feedstock sent by truck						
Basis of Cost Estimate: 35 mile trucking average distance to plant						
Cost to Transport: included above per Ton						
Feedstock Composition - Assay Information						
Feedstock / Product: Waste from Sweet Corn Source of Data: Fed. Of American Society for Experimentl Biology (ASEB) Type of Sample: Cob & Husk Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Type of Sample: Process Residue						
		ASEB		NRB		
		Cob	Husk	Pro. Res.		
Dry Matter				32%		
Moisture						
Cellulose		32.0%	38.0%			
Hemicellulose		42.0%	44.5%			
Lignin		9.0%	6.6%			
Protein		1.7%	1.9%	7.7%		
Ash		1.2%	2.8%	4.9%		
Ether Extract				5.2%		
Crude Fiber				27%		
Acid Detergent Fiber				34%		
Notes:						
ASEB Composition percentages are based on a 100g of fresh material produced						
NRB Composition percentages are based on a 100% dry matter basis.						

Feedstock Composition Data Sheet							
Feedstock / Product: Waste from Cabbage Units: Tons Wet Basis Source of Base Data: NYS Ag Statistics Conversion Factor: 0.32 Source of Conv. Factor: J. Cooper, National Cannery Assn. Other Info:							
Location of Production	Average	1993	1994	1995	1996	1997	
Statewide Production	19,240	23,360	19,488	16,320	14,880	22,154	
Production in North Country Region	0	0	0	0	0	0	
Production on RCBS Farm Site	0	0	0	0	0	0	
Additional Notes: Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.							
Feedstock Costs							
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton							
Source of Data	5 yr Average	1993	1994	1995	1996	1997	
Processing Plants	-\$60.00	n/a	n/a	n/a	n/a	-\$60.00	
Processing Plants	-\$65.00	n/a	n/a	n/a	n/a	-\$65.00	
Transportation Method and Cost							
Method to Transport to Plant: Dry feedstock sent by truck							
Basis of Cost Estimate: 35 mile trucking average distance to plant							
Cost to Transport: included above per Ton							
Feedstock Composition - Assay Information							
Feedstock / Product: Waste from Cabbage Source of Data: Fed. Of American Society for Experimental Biology (ASEB) Source of Additional Data:							
		ASEB					
Dry Matter							
Moisture		92.40%					
Ash		0.7%					
Fat		0.2%					
Total Carbohydrates		5.4%					
Fiber		0.8%					
Protein		1.3%					
Notes: Composition percentages are based on a 100g of fresh material produced							

Feedstock Composition Data Sheet							
Feedstock / Product: Waste from Beets Units: Tons Wet Basis Source of Base Data: NYS Ag Statistics Conversion Factor: 0.41 Source of Conv. Factor: J. Cooper, National Canners Assn Other Info:							
Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	17,045		15,670	18,311	17,589	17,048	16,605
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0
Additional Notes:							
Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.							
Feedstock Costs							
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton							
Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-\$60.00		n/a	n/a	n/a	n/a	-\$60.00
Processing Plants	-\$65.00		n/a	n/a	n/a	n/a	-\$65.00
Transportation Method and Cost							
Method to Transport to Plant: Dry feedstock sent by truck							
Basis of Cost Estimate: 35 mile trucking average distance to plant							
Cost to Transport: included above per Ton							
Feedstock Composition - Assay Information							
Feedstock / Product: Waste from Beets Source of Data: Fed. Of American Society for Experimentl Biology (ASEB) Source of Additional Data:							
			ASEB				
Dry Matter							
Moisture			87.30%				
Ash			1.1%				
Fat			0.1%				
Total Carbohydrates			9.9%				
Fiber			0.8%				
Protein			1.6%				
Notes:							
Composition percentages are based on a 100g of fresh material produced							

Feedstock Composition Data Sheet																															
Feedstock / Product: Waste from Snap Beans Units: Tons Wet Basis Source of Base Data: NYS Ag Statistics Conversion Factor: 0.21 Source of Conv. Factor: J. Cooper, National Cannery Assn. Other Info:																															
Location of Production	Average		1993	1994	1995	1996	1997																								
Statewide Production	14,281		16,279	14,847	16,134	12,789	11,357																								
Production in North Country Region	0		0	0	0	0	0																								
Production on RCBS Farm Site	0		0	0	0	0	0																								
Additional Notes:																															
Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.																															
Feedstock Costs																															
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton																															
Source of Data	5 yr Average		1993	1994	1995	1996	1997																								
Processing Plants	-\$60.00		n/a	n/a	n/a	n/a	-\$60.00																								
Processing Plants	-\$65.00		n/a	n/a	n/a	n/a	-\$65.00																								
Transportation Method and Cost																															
Method to Transport to Plant: Dry feedstock sent by truck																															
Basis of Cost Estimate: 35 mile trucking average distance to plant																															
Cost to Transport: included above per Ton																															
Feedstock Composition - Assay Information																															
Feedstock / Product: Waste from Snap Beans Source of Data: Fed. Of American Society for Experimental Biology (ASEB) Source of Additional Data:																															
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2"></th> <th style="text-align: center;">ASEB</th> </tr> </thead> <tbody> <tr> <td>Dry Matter</td> <td></td> <td></td> </tr> <tr> <td>Moisture</td> <td></td> <td style="text-align: center;">91.00%</td> </tr> <tr> <td>Ash</td> <td></td> <td style="text-align: center;">2.0%</td> </tr> <tr> <td>Fat</td> <td></td> <td style="text-align: center;">0.3%</td> </tr> <tr> <td>Total Carbohydrates</td> <td></td> <td style="text-align: center;">4.6%</td> </tr> <tr> <td>Fiber</td> <td></td> <td style="text-align: center;">1.3%</td> </tr> <tr> <td>Protein</td> <td></td> <td style="text-align: center;">2.2%</td> </tr> </tbody> </table>								ASEB	Dry Matter			Moisture		91.00%	Ash		2.0%	Fat		0.3%	Total Carbohydrates		4.6%	Fiber		1.3%	Protein		2.2%
		ASEB																													
Dry Matter																															
Moisture		91.00%																													
Ash		2.0%																													
Fat		0.3%																													
Total Carbohydrates		4.6%																													
Fiber		1.3%																													
Protein		2.2%																													
Notes:																															
Composition percentages are based on a 100g of fresh material produced																															

Feedstock Composition Data Sheet						
Feedstock / Product: Grape Pomace Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: 0.2 Source of Conv. Factor: J. Cooper, National Cannery Assn. Other Info:						
Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	77,195	49,350	69,791	86,177	99,116	81,539
Production in North Country Region	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0
Additional Notes:						
Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.						
Feedstock Costs						
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton						
Source of Data	5 yr Average	1993	1994	1995	1996	1997
Processing Plants	-\$60.00	n/a	n/a	n/a	n/a	-\$60.00
Processing Plants	-\$65.00	n/a	n/a	n/a	n/a	-\$65.00
Transportation Method and Cost						
Method to Transport to Plant: Dry feedstock sent by truck						
Basis of Cost Estimate: 35 mile trucking average distance to plant						
Cost to Transport: included above per Ton						
Feedstock Composition - Assay Information						
Feedstock / Product: Grape Pomace Source of Data: Fed. Of American Society for Experimental Biology (ASEB) Type of Sample: Grape Skin Source of Additional Data:						
		ASEB				
Dry Matter						
Moisture		81.60%				
Ash		0.4%				
Fat		1.0%				
Total Carbohydrates		15.7%				
Fiber		0.6%				
Protein		1.3%				
Notes:						
Composition percentages are based on a 100g of fresh material produced						

Feedstock Composition Data Sheet						
Feedstock / Product: Apple Pomace Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: 10% for Juice/Cider, 30% for Sauce / Canned Source of Conv. Factor: J. Cooper, National Canners Assn. Other Info:						
Location of Production	Average		1993	1994	1995	1996
Statewide Production	46,132		41,360	45,635	52,875	44,595
Production in North Country Region	0		0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0
Additional Notes:						
Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.						
Feedstock Costs						
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Pay \$10 to \$20 per ton to transport away Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton						
Source of Data	5 yr Average		1993	1994	1995	1996
Processing Plants	-\$60.00		n/a	n/a	n/a	n/a
Processing Plants	-\$65.00		n/a	n/a	n/a	n/a
Transportation Method and Cost						
Method to Transport to Plant: Dry feedstock sent by truck						
Basis of Cost Estimate: 35 mile trucking average distance to plant						
Cost to Transport: included above per Ton						
Feedstock Composition - Assay Information						
Feedstock / Product: Apple Pomace Source of Data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB) Source of WET data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N)						
			S & N		NRB	
			Low	High		
Dry Matter					89%	
Moisture			11.0%	12.5%		
Carbohydrates						
Nitrogen free extract			54.77%	59.29%		
Pectin			15.00%	18.00%		
Crude fiber			15.88%	20.55%	17.00%	
Proteins			4.45%	5.67%	4.90%	
Fat			3.75%	4.65%		
Ash			211.00%	3.50%	2.20%	
Potassium (as K2O)					0.46%	
Phosphorus (as P2O5)					0.11%	
Ether Extract					5.10%	
Acid Detergent Fiber					26%	
Wet Data						
			S & N			
			Low	High		
Dry Matter						
Moisture			66.4%	78.15%		
Carbohydrates			9.5%	21.98%		
Nitrogen free extract			54.77%	59.29%		
Pectin			1.50%	2.50%		
Crude fiber			4.30%	10.50%		
Proteins			1.03%	1.82%		
Fat			0.82%	1.43%		
Ash			0.56%	2.27%		
Potassium (as K2O)			0.2%	1%		
Phosphorus (as P2O5)			0.4%	0.7%		
Ether Extract						
Acid Detergent Fiber						
Notes:						

Feedstock Composition Data Sheet							
Feedstock / Product: Waste from Carrots Units: Tons Wet Basis Source of Base Data: NYS Ag Statistics Conversion Factor: 0.48 Source of Conv. Factor: J. Cooper, National Canners Assn. Other Info:							
Location of Production	Average	1993	1994	1995	1996	1997	
Statewide Production	8,218	12,240	7,392	7,968	6,768	6,720	
Production in North Country Region	0	0	0	0	0	0	
Production on RCBS Farm Site	0	0	0	0	0	0	
Additional Notes: Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.							
Feedstock Costs							
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton							
Source of Data	5 yr Average	1993	1994	1995	1996	1997	
Processing Plants	-\$60.00	n/a	n/a	n/a	n/a	-\$60.00	
Processing Plants	-\$65.00	n/a	n/a	n/a	n/a	-\$65.00	
Transportation Method and Cost							
Method to Transport to Plant: Dry feedstock sent by truck							
Basis of Cost Estimate: 35 mile trucking average distance to plant							
Cost to Transport: included above per Ton							
Feedstock Composition - Assay Information							
Feedstock / Product: Waste from Carrots Source of Data: Fed. Of American Society for Experimentl Biology (ASEB) Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)							
		ASEB	NRB				
Dry Matter			12%				
Moisture		88.0%					
Ash		0.8%	8.2%				
Fat		0.2%					
Total Carbohydrate		9.7%					
Crude Protein		1.1%	9.9%				
Ether Extract			1.3%				
Crude Fiber		1.0%	9.7%				
Nitrogen Free Extract							
Neutral Detergent Fiber			9%				
Acid Detergent Fiber			8%				
Cellulose			7%				
Lignin			0.0%				
Notes: ASEB Composition percentages are based on a 100g of fresh material produced NRB Composition percentages are based on a 100% dry matter basis.							

Feedstock Composition Data Sheet																							
Feedstock / Product: Waste from Peas Units: Tons Wet Basis Source of Base Data: NYS Ag Statistics Conversion Factor: 0.13 Source of Conv. Factor: J. Cooper, National Canners Assn Other Info:																							
Location of Production	Average		1993	1994	1995	1996	1997																
Statewide Production	3,767		2,877	3,206	3,927	3,595	5,229																
Production in North Country Region	0		0	0	0	0	0																
Production on RCBS Farm Site	0		0	0	0	0	0																
Additional Notes: Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.																							
Feedstock Costs																							
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton																							
Source of Data	5 yr Average		1993	1994	1995	1996	1997																
Processing Plants	-\$60.00		n/a	n/a	n/a	n/a	-\$60.00																
Processing Plants	-\$65.00		n/a	n/a	n/a	n/a	-\$65.00																
Transportation Method and Cost																							
Method to Transport to Plant: Dry feedstock sent by truck Basis of Cost Estimate: 35 mile trucking average distance to plant Cost to Transport: included above per Ton																							
Feedstock Composition - Assay Information																							
Feedstock / Product: Waste from Peas Source of Data: Fed. Of American Society for Experimentl Biology (ASEB) Other Information: per 100g of fresh material produced Source of Additional Data:																							
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 80%;"></th> <th style="width: 20%; text-align: center;">ASEB</th> </tr> </thead> <tbody> <tr> <td>Dry Matter</td> <td></td> </tr> <tr> <td>Moisture</td> <td style="text-align: center;">83.00%</td> </tr> <tr> <td>Ash</td> <td style="text-align: center;">1.1%</td> </tr> <tr> <td>Fat</td> <td style="text-align: center;">0.2%</td> </tr> <tr> <td>Total Carbohydrates</td> <td style="text-align: center;">12.0%</td> </tr> <tr> <td>Fiber</td> <td style="text-align: center;">1.2%</td> </tr> <tr> <td>Protein</td> <td style="text-align: center;">3.4%</td> </tr> </tbody> </table>							ASEB	Dry Matter		Moisture	83.00%	Ash	1.1%	Fat	0.2%	Total Carbohydrates	12.0%	Fiber	1.2%	Protein	3.4%
	ASEB																						
Dry Matter																							
Moisture	83.00%																						
Ash	1.1%																						
Fat	0.2%																						
Total Carbohydrates	12.0%																						
Fiber	1.2%																						
Protein	3.4%																						
Notes: Composition percentages are based on a 100g of fresh material produced																							

Feedstock Composition Data Sheet																										
Feedstock / Product: Winery Waste (Grape Pomace from wine production)																										
Units: tons																										
Source of Base Data: NYS Ag Statistics																										
Conversion Factor: 23 pounds of pomace is produced for each 100 pounds of wine																										
Source of Conv. Factor: Gene Pierce, President of Glenora Winery																										
Other Info:																										
Location of Production	Average	1993	1994	1995	1996	1997																				
Statewide Production	13,853	10,702	15,036	12,930	20,525	10,074																				
Production in North Country Region	0	0	0	0	0	0																				
Production on RCBS Farm Site	0	0	0	0	0	0																				
Additional Notes:																										
Wine data collected per gallon produced. Transferred into ton data based on 180 gallons / ton figure provided by Gene Pierce of Glenora Winery.																										
32% of wine (and 32% of pomace) is in the Finger Lakes region, the rest near Hudson, Erie, and Long Island.																										
Feedstock Costs																										
Market or Disposal Method: Land spread on-site. No value.																										
Additional Market or Method: Some wineries will make grapeseed oil or mix into compost, but none in New York.																										
Additional Costs not Quantified:																										
Unit of measure for cost: Dollars per Ton																										
Source of Data	5 yr Average	1993	1994	1995	1996	1997																				
Glenora Winery / NY Wine Assoc.	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00																				
Transportation Method and Cost																										
Method to Transport to Plant: Dry feedstock sent by truck																										
Basis of Cost Estimate: 35 mile trucking average distance to plant																										
Cost to Transport:	\$7.75	per Ton																								
Feedstock Composition - Assay Information																										
Feedstock / Product: Winery Waste (Grape Pomace from wine production)																										
Source of Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)																										
Source of Additional Data:																										
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">NRB</th> </tr> </thead> <tbody> <tr> <td>Dry Matter</td> <td style="text-align: right;">91%</td> </tr> <tr> <td>Crude Protein</td> <td style="text-align: right;">13.0%</td> </tr> <tr> <td>Ether Extract</td> <td style="text-align: right;">7.9%</td> </tr> <tr> <td>Total Ash</td> <td style="text-align: right;">10.3%</td> </tr> <tr> <td>Crude Fiber</td> <td style="text-align: right;">31.9%</td> </tr> <tr> <td>Neutral Detergent Fiber</td> <td style="text-align: right;">55%</td> </tr> <tr> <td>Acid Detergent Fiber</td> <td style="text-align: right;">54%</td> </tr> <tr> <td>Cellulose</td> <td></td> </tr> <tr> <td>Lignin</td> <td style="text-align: right;">35%</td> </tr> </tbody> </table>								NRB	Dry Matter	91%	Crude Protein	13.0%	Ether Extract	7.9%	Total Ash	10.3%	Crude Fiber	31.9%	Neutral Detergent Fiber	55%	Acid Detergent Fiber	54%	Cellulose		Lignin	35%
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Notes:																										
Composition percentages are based on a 100% dry matter basis.																										

Feedstock Composition Data Sheet																																	
Feedstock / Product: Cherry Pomace Units: Tons Source of Base Data: NYS Ag Statistics Conversion Factor: 0.15 Source of Conv. Factor: J. Cooper, National Cannery Assn. Other Info:																																	
Location of Production	Average	1993	1994	1995	1996	1997																											
Statewide Production	1,283	1,133	1,770	1,485	1,050	975																											
Production in North Country Region	0	0	0	0	0	0																											
Production on RCBS Farm Site	0	0	0	0	0	0																											
Additional Notes: Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.																																	
Feedstock Costs																																	
Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per Ton																																	
Source of Data	5 yr Average	1993	1994	1995	1996	1997																											
Processing Plants	-\$60.00	n/a	n/a	n/a	n/a	-\$60.00																											
Processing Plants	-\$65.00	n/a	n/a	n/a	n/a	-\$65.00																											
Transportation Method and Cost																																	
Method to Transport to Plant: Dry feedstock sent by truck																																	
Basis of Cost Estimate: 35 mile trucking average distance to plant																																	
Cost to Transport: included above per Ton																																	
Feedstock Composition - Assay Information																																	
Feedstock / Product: Cherry Pomace Source of Data: No data available Source of Additional Data:																																	
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Dry Matter																																	
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Total Carbohydrates																																	
Fiber																																	
Protein																																	
Notes:																																	

Feedstock Composition Data Sheet						
Feedstock / Product: Dedicated Feedstock Willow Units: Dry Tons Source of Base Data: SUNY ESF Conversion Factor: 6 dry tons per acre Source of Conv. Factor: SUNY ESF Other Info: low production now on test farms only						
Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	112	20	20	20	150	350
Production in North Country Region	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0
Additional Notes: Willow is well suited for idle lands with lower soil quality than corn acreage. Willow is only being tried on test plots. SUNY predicts between 10,000 and 80,000 acres of willow in New York State by 2015 for electricity production. Additional willow may be grown for ethanol production. Land availability is being measured by NYSTEC. Numbers for 1993-1995 are estimates based on known information about project history						
Feedstock Costs						
Market or Disposal Method: Burned for electricity. Cost based on test farm estimates by Anteres Grp. Additional Market or Method: Additional Costs not Quantified: Unit of measure for cost: Dollars per dry ton						
Source of Data	5 yr Average	1993	1994	1995	1996	1997
Salix Consortium / SRC	\$128.30					\$128.30
Transportation Method and Cost Method to Transport to Plant: Dry feedstock sent by truck Basis of Cost Estimate: 35 mile trucking average distance to plant Cost to Transport: \$7.75 per Ton						
Feedstock Composition - Assay Information						
Feedstock / Product: Dedicated Feedstock Willow Source of Data: Environmental Science School / NYSEG study of local willows Location of Sample: Tully test fields						
Carbon:	40.38%	Moisture:	10.00%			
Hydrogen:	6.23%	Ash:	1.47%			
Nitrogen:	0.46%	Btu/lb (dry):	8392			
Oxygen:	41.40%	Btu/lb (wet):	7553			
Sulfur:	0.05%					
Notes:						

Appendix C

**Evaluation of Biomass-to-Ethanol Processing
for
Building a Bridge to the
Corn Ethanol Industry**

(Raytheon Engineering and Constructors, Inc.)

EVALUATION OF
BIOMASS TO ETHANOL PROCESSING

FOR
BUILDING A BRIDGE TO THE
CORN ETHANOL INDUSTRY

FOR
NYSTEC
NEW YORK STATE
TECHNOLOGY ENTERPRISE CORPORATION
TA029/SC01
DE-AC-36-98-GO10337

BY: RAYTHEON ENGINEERING & CONSTRUCTORS, INC.
PROJECT 78849.001

JULY, 1999

NREL Draft Final Report

Building a Bridge to the Corn Ethanol Industry



INTRODUCTION

This evaluation is produced in support of New York State Technology Enterprise Corporation Biomass to Ethanol Study. This report contains:

- Non-specific site selection criteria
- An evaluation of the Robbins Corn & Bulk Service Grain processing facility, located in the Socketts Harbor, NY for the feasibility of producing ethanol from biomass
- Review of NREL process design and database
- The sizing of a biomass conversion plant and the next steps to building the facility.
- Cost estimate for non-site specific biomass plant
- The sizing of a corn to ethanol conversion plant for comparison to the biomass plant
- Cost estimate for non-site specific corn to ethanol plant.

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Building a Bridge to the Corn Ethanol Industry



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- III. CORN TO ETHANOL PLANT REFERENCE
 - A. Process Description
 - B. Process Plant Summary Construction Cost Estimate
 - C. Priced Equipment List
 - D. Plant Operating Cost Estimate
 - E. Plant Labor Estimate
 - F. Process Flow Diagrams

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I. ROBBINS CORN AND BULK SERVICE EVALUATION

A. General Site Selection Criteria

Based on the Site Layout Study, a minimum site of 35-40 acres is required for the biomass plant. The biomass Site Layout Study has dimensions of 1320' x 1080' (33 acres m/l) in a feasibility type arrangement. This size allows for the plant to be sized at 80 MM gal/yr, if planned up front. This is a feasible size plant based on review of the NREL data and use of the proposed biomass handling system extrapolated to four (4) bale conveyors (see Process Description).

There are assumptions made about efficiency of land area usage, soil support characteristics, logistics, and utilities in the Site Layout Study that may not apply to all sites. Additional considerations should be given to odor buffer space, expandability, and especially possible co-location of a grain to ethanol processing plant that would require 35 to 40 acres.

Land Area Use

The layout and estimate assumes that railroad service is available near the edge of the property. It also assumes that there are no strange boundary conditions, rights-of-way restrictions, or other restricted areas within the limits of the site, such as springs, sink holes, wet lands, etc.

Soil Support Characteristics

Poor soil conditions could cause the plant to expand in area to provide the necessary support for large tanks and heavy equipment. Special support structures are not generally included as identified items in a feasibility study (piles, caissons, removal and replacement of subsoils.)

Logistics

Truck traffic could be as high as 240 to 250 deliveries per day of biomass and other materials (about a truck every 5 minutes entering and leaving). These will be mostly flatbed trucks loaded with 30,000 to 44,000 pound loads of biomass, delivering 5 to 6 days per week. The other materials will be delivered in typical over-the-road semi-tractor trailer units. The roadways need to be state highway or Interstate class. I doubt that county level roads will hold up under the traffic loads. Typical rural roadways for immediate plant access are not acceptable.

Rail access is a must have for moving the ethanol. At 60 MM gal/yr, rail traffic will be about 2000 cars/yr (30,000 gal/car rated at 34,500 gal capacity) just for the ethanol. Unleaded gas should probably also come by rail because the backhaul is less costly. If railroad transportation were not used, the equivalent ethanol truck trailer traffic would be about 5 times the railcar traffic. This would probably overwhelm the roadway access to the plant.

Utilities – Power

The plant will need a 100 KV power source. I do not know the standard voltage used in NY near where this plant will be located, but if it is 115 KV, 145 KV, or some other voltage, it does not

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matter (15 KV power is not sufficient). Power consumption could peak as high as 20-30 Megawatts at the site when fully built out. Cost information for power transmission lines are not readily available because of the specialized applications installed by power companies.

Utilities - Water

Per the simulation, the water make-up to the plant is 500 gal/min. I would suggest that 600 gal/min be used as the basis. There are warnings around the water balance in the simulation that will take some engineering effort, that is not currently funded, to verify the exact needs. There also may be some ways to reduce the fresh water requirement. If water cannot be obtained from a public system, a 600 gal/min well, a standard size dependent on the aquifer available, would be covered by the current contingency.

Utilities - Natural Gas

There is a need for 1600 therms/hr to run the plant during startup before there are byproducts available for heat and power generation. There might be an opportunity to gain some revenue during operation with the byproducts. There will be about 1500 therms/hr available that could be used for additional power co-generation on a permanent basis with slightly larger boilers and generator.

Other Infrastructure Elements

There will be water discharged from the plant. There will be storm water runoff that needs to go its normal way to the water shed. There will be domestic water discharge. The domestic water preferably needs to discharge to a sewer system for sanitary wastes. However, it might run to a septic system. There will be laboratory water discharges. The laboratory preferably needs to discharge to a sewer system for sanitary wastes. If it cannot, then it would go to the process wastewater treatment system. It would be more convenient, but not necessarily a requirement, to discharge to a city sanitary sewer system than to treat all the different water discharges from the plant at the plant. Process wastes will still be treated at the plant for economical reasons.

The process is shown to discharge only vapors and wet sludge. There can be various vapors that are odoriferous at times, even though steps are taken to control emissions. In the simulation and discussion in NREL's reports, the wet sludge is landfilled. There is an opportunity to sell the wet sludge to someone else, as is done in other agricultural processing plants, as well as prepare it for land application on the farmer's fields to replenish micronutrients.

An existing boiler of about 270,000 pounds per hour capacity of 150 PSIG or greater steam could be utilized for process steam in the biomass plant. Likewise, the corn plant could use about 150,000 pounds per hour of 150 PSIG steam for process steam. The two plants could synergize on the steam, waste water treatment, power supply/use, and some of the logistics, if located next to each other.

B. Evaluation

Robbins Corn and Bulk Service (RCBS) was visited on March 10, 1999 (see attached notes). This service consists of a grain storage and transfer facility with grain dryer and scales (see

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Building a Bridge to the Corn Ethanol Industry



attached pictures). Storage facilities like this are key to a grain ethanol plant to lower the bulk storage requirements at the plant. However, the storage capacity is too small compared to the requirements needed on-site for even a 15MM gal/year corn to ethanol plant. Additionally, the area served by this size operation will not provide sufficient biomass to support a large plant operation.

The utility services nearby are designed and installed for rural, and farm usage and could not support the plant needs without major upgrades. The electric utility services would need to be run from the nearest major power substation as an independent line.

A separate well could provide water. There is a small city water system close by, but it does not appear to be sized for this type of intended operation.

Natural gas would probably need to be piped from the main north-south trunk line over 4 miles away. There appear to be only small services close by for residential and small business usage.

The county road life would be shortened with the predicted industrial truck traffic loads. Ethanol products could be trucked to the rail service for bulk distribution, or to other nearby users, but at much greater operating costs.

The North Country Area Potential chart analysis for biomass feedstock shows support for about a 24MM gal/yr plant. If Oswego and 1/3 of Oneida county are added to the North Country biomass pool, the plant capacity approaches 30MM gal/yr (within the 50-60 mile radius from RCBS).

The State Wide Potential chart analysis for biomass feedstock shows support for about 4 – 60MM gal/yr plants or 3 – 80MM gal/yr plants. A plant needs to be located in the middle of a broad area to supply feedstock. RCBS, Watertown, and even some upcoming sites (see Charthage on the Internet) suffer from the effects of nearby large bodies of water that do not produce biomass for this plant. A place like Griffiss AFB, or the shutdown Miller Brewery are better located to have sufficient biomass close by.

In conclusion, there are other sites that offer better opportunities for capacity and reduced capital investment for a plant like this. The other possible sites could be near Rome, or Syracuse, or in west central New York.

POTENTIAL RON ROBBINS FARM ALCOHOL PRODUCTION BASIS																			
MATERIAL COMPONENT		CORN STOVER	GRASS	STRAW	PAPERMILL RESIDUE	CORN	BREWERY SOLIDS	CHEESE WHEY	SWEET CORN	CABBAGE	BEETS	SNAP BEANS	GRAPES	APPLE POMACE	CARROTS	PEAS	WINERY WASTE	CHERRIES	WILLOW BIOMASS
UNITS																			
Production Rate	tons/yr	1,339	750	212	0	1,962	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent Solids	%	85.00%	88.00%	85.00%	45.00%	89.00%	92.00%	7.00%	32.00%	7.60%	12.70%	9.00%	18.40%	89.00%	12.00%	17.00%	91.00%	18.40%	90.00%
Percent Water	%	15.00%	12.00%	15.00%	55.00%	11.00%	8.00%	93.00%	68.00%	92.40%	87.30%	91.00%	81.60%	11.00%	88.00%	83.00%	9.00%	81.60%	10.00%
Gallons of Alcohol		87,356	43,932	12,137	0	214,535	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SOLUBLE SOLIDS		74.47%	66.94%	74.00%	65.80%	95.30%	55.43%		54.40%										
Glucose (SS)	%	45.39%	37.87%	37.00%	49.70%	75.30%	27.86%	74.10%	43.25%	4.99%	9.70%	4.30%	15.60%	54.84%	9.49%	11.78%	17.06%	15.60%	52.32%
Xylose (SS)	%	23.86%	22.31%	24.00%	4.80%		15.03%												18.65%
Arabinose (SS)	%	2.00%	3.78%		0.70%		7.12%												1.89%
Other Sugars (SS)	%	1.11%	2.98%				2.33%												6.19%
Cellulobiose (SS)	%																		
Glucose Oligomers (SS)	%																		
Xylose Oligomers (SS)	%																		
Other Oligomers (SS)	%																		
Acetate (SS)	%																		
OH	%																		
SO ₄ (SS)	%																		
Others Soluble Solids	%	2.11%		13.00%	10.60%	20.00%	3.09%	15.60%	11.15%	1.49%	1.60%	2.00%	2.20%	8.90%	1.26%	3.52%	20.70%	2.20%	
INSOLUBLE SOLIDS		25.53%	33.06%	26.00%	34.20%	4.70%	44.57%	10.30%	45.60%										
Cellulose (IS)	%					2.00%			35.00%	0.80%	0.80%	1.15%	0.60%	17.52%	0.97%	1.11%	17.38%	0.60%	
Xylan (IS)	%																		
Arabinan (IS)	%																		
Other Sugar Polymers (IS)	%																		
Cellulase (IS)	%																		
Biomass (IS)	%																		
Zymo (IS)	%																		
Lignin (IS)	%	18.53%	25.29%	15.00%	29.30%	1.30%	40.48%		7.80%					15.87%			35.00%		20.47%
INORGANICS	%	7.00%	5.80%	11.00%	4.90%	1.40%	4.09%	10.30%	2.80%	0.70%	1.09%	1.95%	0.40%	2.70%	0.77%	1.07%	10.30%	0.40%	0.49%
Ca ⁺⁺ (IS)	%																		
Other Insoluble Solids	%																		
Carbon Dioxide	%																		
Methane	%																		

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POTENTIAL NORTH COUNTRY ALCOHOL PRODUCTION BASIS

[illegible]

North Country



Location

Northern New York is bordered by Lake Ontario on the west, the Adirondack mountains to the south, Vermont and Lake Champlain to the east, and the St. Lawrence Seaway and the provinces of Quebec and Ontario, Canada, to the north. The largest of New York's economic regions in area, it is the smallest in population.

Area

9,776 square miles

Weather

Mean Daily Temperature:

January 14.5 F

July 69.0 F

Workforce

Labor Force: 187,900

Households: 144,196

Total Personal Income: \$6.6 billion

Per Capita Income: \$15,235

Median Home Sales Price: \$55,000

Population: 432,024

Clinton County 86,978

City of Plattsburgh 20,940

Essex County 37,950

Franklin County 49,121

Jefferson County 114,891

City of Watertown 27,869

Lewis County 27,661

St. Lawrence County 115,490

Village of Massena 11,468

City of Ogdensburg 13,174

Local Utilities

Niagara Mohawk Power Corp.

Offers negotiated flexible electric rates for many types of new businesses, negotiable gas transportation rates and fixed rate gas discounts.

New York State Electric & Gas Corp.

Offers negotiated flexible electric and fixed rate electric discounts for many types of new businesses and negotiable firm gas transportation service.

Market Access

The region's proximity to major Canadian population centers makes it a highly desirable location for companies serving the North American market, and for Canadian companies wishing to establish a branch operation in the U.S. Key Canadian markets (Montreal and Ottawa) are within an hour's drive.

Industries

Northern New York's economy is based primarily on the development of its abundant natural resources, including vast stretches of timber and valuable mineral deposits like zinc, talc and dolomite. Three industries-dairying, paper manufacturing and aluminum products-account for nearly half of all the manufacturing jobs in the region. Other

major industry clusters include wood products, pharmaceuticals, apparel manufacturing and plastics.

Tourism plays a central role in the region's economy, and is a major employer. The Thousand islands, the Champlain Valley and the Adirondack Park are destinations for thousands of visitors each year.

Economic Development Zones

Lowville/Martinsburg
Moriah/Port Henry
Ogdensburg
Plattsburgh
Potsdam
Watertown

Selected Employers

ALCOA, Massena
James River Corporation, Carthage and Gouverneur
Champion International Corp., Deferiet
Corning, Canton
Mitel, Ogdensburg
Georgia Pacific, Plattsburgh
Reynolds Metals Company, Massena
International Paper Co., Ticonderoga
Wyeth Ayerst Laboratories, Rouses Point

Transportation

Highways: Two major interstate highways provide access. The eastern part of the region is served by the scenic Adirondack Northway, 1-87, which connects Albany and the New York State Thruway with Canada. 1-81 passes through the western part of the region connecting it with Syracuse and the New York State Thruway to the south and with major population and industrial centers to the north in Canada.

Air Service: Passenger service is provided at Watertown, Ogdensburg, Plattsburgh, Massena, and Saranac Lake.

Rail Service: Commercial rail service is provided by Conrail and Canadian Pacific; Amtrak operates passenger service on the eastern portion of the region from Montreal south to New York City.

Bus Service: Regular service is provided by Greyhound Bus Lines and Adirondack Trailways in several communities throughout the region.

Port Facilities: The Port of Ogdensburg provides deep-water port facilities for ocean-going vessels via the St. Lawrence Seaway, and many Northern New York businesses use the nearby Port of Montreal, the second-largest inland port in North America. The Champlain canal, part of the New York State Canal System, connects Lake Champlain and Montreal with the Hudson River and New York City, serving recreational as well as commercial users.

Education

Ten colleges and universities enroll close to 30,000 students, including two four-year colleges at Plattsburgh and Potsdam operated by the State University system. Clarkson University is home to the state's Center for Advanced Technology in Advanced Materials Processing.

Major Colleges and Universities Enrollment
Clarkson University, Potsdam 2,978
Paul Smith's College of Arts and Sciences 809
St. Lawrence University, Canton 1,983
SUNY College of Technology at Canton 2,278
SUNY College at Potsdam 4,562
SUNY College at Plattsburgh 6,160

Health Care

Champlain Valley Physicians Hospital, Plattsburgh
House of Good Samaritan Hospital, Watertown
A. Barton Hepburn Hospital, Ogdensburg
Adirondack Medical Center, Saranac Lake
Massena Memorial Hospital, Massena

Quality of Life

Northern New York is an area of outstanding physical beauty. Some natural attractions include the Thousand Islands in the St. Lawrence River, Ausable Chasm, the Adirondack Park and its 46 "high peaks," and Lake Champlain. The region is a four-season outdoor vacationland, with world-class alpine and nordic skiing, challenging hiking and backpacking, canoeing, kayaking, whitewater rafting, fishing and golf. Lake Placid, site of the 1932 and 1980 Winter Olympics, is a major four season resort area. The Crane School of Music in Potsdam and the Remington Art Museum in Ogdensburg are two of the region's unique cultural offerings.

Prepared by NMPC, Syracuse New York - 1-800-944-6460

POTENTIAL STATE WIDE ALCOHOL PRODUCTION BASIS

MATERIAL COMPONENT	UNITS	CORN STOVER	GRASS	STRAW	PAPERMILL RESIDUE	CORN	BREWERY SOLIDS	CHEESE WHEY	SWEET CORN	CABBAGE	BEEFS	SNAP BEANS	APPLE POMACE	CARROTS	PEAS	WINERY WASTE	CHERRIES	WILLOW BIOMASS
Production Rate	tons/yr	1,208,000	1,848,000	294,740	643,000	208,000	2,901,690	219,853	149,856	19,240	17,045	14,281	77,195	8,218	3,767	13,853	1,283	230
Percent Solids	%	85.00%	88.00%	85.00%	45.00%	89.00%	92.00%	7.00%	32.00%	7.60%	12.70%	9.00%	18.40%	12.00%	17.00%	91.00%	18.40%	91.36%
Percent Water	%	15.00%	12.00%	15.00%	55.00%	11.00%	8.00%	93.00%	68.00%	92.40%	87.30%	91.00%	81.60%	88.00%	83.00%	9.00%	81.60%	8.64%
Gallons of Alcohol		78,809,770	108,248,580	16,873,296	11,133,586	22,743,790	126,843,917	1,297,957	2,360,597	8,305	23,899	6,290	252,199	10,652	8,586	244,780	4,192	16,634
		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SOLUBLE SOLIDS																		
Glucose (SS)	%	74.47%	66.94%	74.00%	65.80%	95.30%	55.43%		54.40%									52.32%
Xylose (SS)	%	45.39%	37.87%	37.00%	49.70%	75.30%	27.86%	74.10%	43.25%	4.99%	9.70%	4.30%	15.60%	9.49%	11.78%	17.06%	15.60%	18.65%
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Others Soluble Solids	%	2.11%		13.00%	10.60%	20.00%	3.09%	15.60%	11.15%	1.49%	1.60%	2.00%	8.90%	1.26%	3.52%	20.70%	2.20%	
INSOLUBLE SOLIDS																		
Cellulose (IS)	%	25.53%	33.06%	26.00%	34.20%	4.70%	44.57%	10.30%	45.60%									
Xylan (IS)	%					2.00%			35.00%	0.80%	0.80%	1.15%	17.52%	0.97%	1.11%	17.38%	0.60%	
Arabinan (IS)	%																	
Other Sugar Polymers (IS)	%																	
Cellulase (IS)	%																	
Biomass (IS)	%																	
Zymo (IS)	%																	
Lignin (IS)	%	18.53%	25.29%	15.00%	29.30%	1.30%	40.48%		7.80%				15.87%			35.00%		20.47%
INORGANICS																		
Ca ⁺⁺ (IS)	%	7.00%	5.80%	11.00%	4.90%	1.40%	4.09%	10.30%	2.80%	0.70%	1.09%	1.95%	0.40%	0.77%	1.07%	10.30%	0.40%	0.49%
Other Insoluble Solids	%																	
Carbon Dioxide	%																	
Methane	%																	
Oxygen	%																	
Nitrogen	%																	
Ammonia	%																	
Other Inorganic Ions	%		1.97%															
Total Potential Alcohol		371,449,751 gal/yr																
Note: Corn rate includes credit for DOGS replacement of Corn Grain as feed for dairy cows.																		
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II. BIOMASS PLANT EVALUATION

A. GENERAL DISCUSSION

The simulation provided by NREL is the basis for evaluation of the biomass plant. Corn stover, hay and straw were the most promising feedstocks (see tables). The corn stover and grass feedstock characteristics were run in the simulation at 200,000 pounds per hour to bracket the plant around the three feedstocks. The results were very similar. A plant can be built to run 200,000 pounds per hour of these biomasses. It could be built to run 300,000 pounds per hour or more rather easily, the upper limit being dependent on the logistics of the biomass feedstock. The 200,000 pounds per hour rate was chosen to be used on a solids processing basis closely comparable to NREL's solids rate.

Based on the results, the economic evaluation should come very close to NREL's process economics. The cost estimate is conservative with a 25% contingency on total field and engineering costs, which is typical for this stage of project development. Cost offsets (deletions and additions) were made from NREL's cost estimate in feedstock storage and handling, fermentation, boiler, and generator costs. The feedstock storage and handling was redefined from a woodchip handling system (see NREL Process Description) to a bale handling system. Fermentation tank size was increased to a larger proven design that reduced the number of tanks. This increased the cost per tank, but resulted in overall cost reduction by reducing the number of tanks required. The boiler cost reduction is based on some preliminary discussions with a vendor. The increased steam turbine generator costs are based on a recent Raytheon project purchase. The cost offsets are a typical characteristic of a cost estimate as a project develops. It appears there maybe opportunities to reduce some other costs, but it is also too early to reduce the risk assessment of the 25% contingency for the current estimate.

Overall, the biomass plant appears feasible on a process basis. Further testing and evaluation of feedstocks and pilot plant test runs are needed for confirmation of the assumptions made in the simulation. Some of the areas for testing and evaluation are:

- The feedstock needs a more detailed chemical analysis for modeling in the simulation.
- The ash content of the feedstocks needs further definition.
- The feedstock needs to be test run in the shredder and hammermill to verify handling characteristics.
- Determine the final size requirements of the feed stock to be run through the process to optimize conversion rates and equipment requirements. Maybe we do not need the second reduction.
- The pilot plant run could also better define byproduct lignin and solids mixture characteristics, which are needed for better design of the evaporator and boiler. When these are done, further engineering can be done to refine the design.

An opportunity exists to find a commercial use and financial return on the CO₂ and sludge produced in the plant. This would improve economics. It has not been considered in the cost analysis.

Further engineering design could change certain equipment relationships resulting in either more or less space requirements for the plant.

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B. OPTIMIZATION OPPORTUNITIES

Blowdown Tank Hydrolyzate Screw Conveyor

The screw conveyor can be replaced by a pump.

Plant and Equipment Sizing

The size of the dry biomass material handling equipment seems to make the delivery systems run as units of 20,000,000 gallons of ethanol plant capacity. Maybe there are other areas that fit this pattern, such as the dehydration.

When looking at the fermentation, and after contact with a prominent tank manufacturer, the main fermentation could follow the same size pattern. By selecting the state of the art fermenter size, the capacity was met by 15 fermenters (13 required). This allowed cost savings by reducing the number of fermenters in spite of a slightly higher unit cost. Maybe the Seed Fermenters have a similar opportunity.

Lime Delivery and Storage

Lime delivery was proposed as railcar load lots. Based on the usage rate, this could be met by two railcars per year. A more reasonable delivery rate would be one tractor trailer delivery per month allowing for a smaller storage and less unloading equipment on site. Most hopper trailers have unloading systems on the trailer. The driver is then responsible to unload the trailer. This shifts capital to operating expense reducing the investment in the plant and the cost of labor.

Evaporator System

Previous experience in evaporator design has shown that the lignin streams in paper plants have been concentrated in evaporators to 75% to 80% solids for firing as liquids. The two-third effect bodies following a single second effect body appears strange. Closer examination of the system was not possible given the time and funding restrictions for this study. It was assumed that the number of evaporator bodies and the heat balance are correct. There would seem to be cost reduction opportunities here.

Boiler

Boilers have fired liquid lignin streams before. It would appear to be easier and less capital intensive to fire the solid by-products as a part of the liquid lignin stream. The biosolids in this plant are not generally abrasive. With attention given to this area in preliminary engineering for a commercial plant, this should be easily realizable.

There is a cost break in the boiler at 1100 PSIG operating pressure. The boiler was priced as readily available catalogue standard, 900 PSIG operating pressure, with burner and fire box modifications to fire natural gas and liquid by-product. There are similar 900 PSIG systems currently used in co-generation in agricultural plants

Gas firing is needed to startup the plant before by-product fuel becomes available. Furthermore, the natural gas flame should be maintained at some yet to be determined rate to

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insure ignition and combustion of the by-product. Based on previous experience, a 5 MMBTU rate for each furnace was selected for the cost model.

Water Balance

There is a mass balance warning and a water warning on the splitter for the process condensate flows for the plant. It appears the model is normalizing the split based on a predetermined flow requirement, which is not met. With the change to the biomass water content, the plant may be short of water. A more in-depth analysis is needed. Allowance for extra water was made in the cost analysis because the amount of funding does not allow further study within the budget and schedule.

Infrastructure

Because of the size of this plant, total truck removal/delivery of the alcohol produced is not practical, nor is the delivery of all the enzyme needed for the fermentation. The utilization of railcars for the alcohol removal/delivery is very necessary. The onsite manufacture of enzymes is very cost effective relative to transportation costs (per vendor discussions).

Operating Costs

Enzyme cost is very difficult to predict subject to a negotiated licensing arrangement with a supplier, or other development in enzymes. Generally, purchasing enzymes will have a very negative impact on plant profitability. Several corn wet milling companies produce their own enzymes independent from any major enzyme manufacturer.

Material of Construction for Acid Hydrolysis Reactor

As requested, materials of construction were checked for the paper plant digesters. Most recent systems are not acid based, which allows for carbon steel construction. The acid based systems use stainless type materials. Glass lined vessels are not known to be used. The glass would tend to cause problems in some applications, if it found its way into the pulp stock.

There are other opportunities not mentioned or examined because of time and budget constraints.

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C. PROCESS DESCRIPTION

Introduction

This 60,000,000-gallon per year plant is based on processing 200,000 pounds per hour of baled straw, hay, or corn stover feed stock. The feedstock characteristics are as shown in the attached Feed Stock Composition Data Sheet. The process is based on the National Renewable Energy Laboratory (NREL) Aspen simulation r9901f, design database, and process descriptions.

The following description is only intended to provide an overview with details about the biomass feed handling system. As previously mentioned, the process is based on NREL's simulation and process design for wood chips. The design and simulation did not contain a developed biomass feed handling system. The following is a more detailed description of the biomass feed handling system. The process receives square baled field crop residues. The bales are shredded and chopped to 3/4 inch size pieces for processing.

Biomass Feed Handling

The biomass handling and delivery system approach focused on utilizing existing equipment expected to be found on the farm. After a short discussion with Ron Robbins, it was determined to focus on flat bed truck delivery of square bales loaded by farmers. Both round and square bales are produced, and shredded on a small scale for animal feed. It was determined that the farmer does not have sufficient shredding equipment to pre-shred biomass for delivery. Square bales are easier to truck than round bales. And square bales are easier to convey and feed to the shredder.

The shredded and chopped biomass is not expected to exhibit free flow characteristics making truck and storage bin unloading troublesome. Furthermore, the sized biomass is very low density, which does not work well with certain types of equipment, like bucket elevators.

Deliveries of material are planned to be accepted five (5) days per week except holidays, whether it rains, snows, or shines, starting at 7 a.m. The biomass will be received at the plant in square bales of approximate dimensions of 32" X 32" x 7 feet long loaded long axis parallel to the long axis of a standard flat bed truck (45'L x 8'W x 52"H). These loads comprise 54 bales (3 high, 3 wide, and 6 long) and need to be covered to preclude moisture uptake from direct water impacts. Each bale weighs approximately 600, 750, or 900 pounds at acceptable moisture levels, depending on the material, straw, hay, or corn stover (biomass), respectively. Each truckload of material is weighed in, sampled for moisture, unloaded, and weighed out in less than an hour. No mixed truckloads of material are accepted. Loads will be scheduled by logistics supervisors to smooth the flow and ensure continuous plant operation. Seasonal runs of hay, straw, and corn stover are expected.

After weighing and sampling has been completed, the delivery trucks are marshaled in a waiting area to be driven along either side of the three (3) bale conveyors, as open spots become available. The each bale conveyor has four (4) truck spots for unloading. Each bale conveyor has two (2) unloading cranes that each unloads one truck at a time at a rate of one (1) bale every 30 seconds. Thus, the equivalent plant bale unloading rate is one bale every 15 seconds on each bale conveyor on two 8 hour shifts, for up to 11,520 bales per day. Based on

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preliminary vendor data on a readily available crane, a crane should be able to move a bale from the truck to the bale conveyor in less than 20 seconds over the longest traveled path. Allowing 10 seconds extra (50% more) travel time provides plenty of buffer to realize moving one bale every 30 seconds from the flat bed truck to the bale conveyor.

Each bale conveyor is the first piece of equipment of a processing subsystem that moves the biomass from truck to surge storage to acid hydrolysis. The individual subsystems comprise:

- A bale conveyor
- A bale shredder feeder
- A bale shredder (- 4 inch)
- A shredded biomass take-away conveyor
- A destoner with tramp metal magnet
- A hammermill (-3/4 inch)
- A pneumatic storage fill conveyor
- A storage bin
- A bin unloader
- A bin unloader screw conveyor
- A pneumatic process feed conveyor to wetting tank
- An acid hydrolysis tank feed pump
- A acid hydrolysis tank
- A flash tank feed pump

At the flash tank, all three systems merge to the rest of the plant described by NREL.

Each conveyor unloading system is capable of 240 bales per hour. This is 433,200 pounds per hour for straw, 504,000 pounds per hour for hay, or 648,000 pounds per hour for corn stover, if only one kind of material is handled. These rates will provide varying degrees of buffer from 2.2 days to 5.8 days for each five-day operational period. The shorter buffer times are during the summer months.

Biomass Surge Storage

Each storage bin retrieval system can operate at either 67,000 or 100,000 pounds per hour to provide full capacity with either 3 or 2 subsystems operating, respectively, for on-line maintenance time. Thus, a whole subsystem including the bin can be emptied and shutdown for maintenance, as well as provide for interruption of service due to unforeseen circumstances without impacting plant capacity.

To reach the solids delivery rate for straw, three (3) bale subsystems need to be unloading at the same time. If there were an unscheduled maintenance shutdown for pure straw delivery, straw delivery could be scheduled to include Saturday to make up the difference. Assuming straw delivery only during the warm months, the amount of surge storage required could be reduced since snow delays are not likely. Separate unloading lines could run different materials, for instance, two (2) hay and one (1) straw.

Biomass delivery needs can be met at an average rate of 214 trucks, one truck every 4 to 5 minutes (13.3 per hour), per 16 hour day. There will be other truck deliveries and all trucks will not arrive on a precise schedule. It is estimated that biomass truck traffic alone could approach 240 vehicles a day.

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Fermentation Slurry Preparation

After the dry material is retrieved from storage, it is wetted and acid hydrolyzed at high temperature and pressure to break down the long chain cellulose fibers and the naturally occurring acetate groups bound to the cellulose. Then, the slurry is steamed flashed to further break apart the fibrous cellulose. The recovered slurry is then separated into a liquid stream and a wet solids stream. The liquids are sent to ion exchange for reduction of acetic acid and overlimed for reduction of other impurities that are toxic impediments to the fermentation. The liquid and solids are then recombined to reform a prepared slurry. The slurry preparation results in a pH adjusted, properly diluted, and conditioned feed stock for fermentation that has retained most free sugars or starch intermediates produced during this prehydrolysis.

Fermentation

The conditioned fermentation slurry stream is then split and sent to the main fermenters, the cellobiase enzyme production fermenters, and the cellulase enzyme production fermenters.

The cellulase enzyme and cellobiase enzymes are produced on site rather than transported to the site to reduce costs because of the volume needed to support the plant. The two enzymes work together for Simultaneous Saccharification and Co-Fermentation (SSCF) production of alcohol in the main fermenters.

The fermentations are based on wood chip to alcohol research studies done by NREL over the last few years. Wood chips are known to vary from corn stover, grasses, and straw in the amount of lignin contained in the biomass. The fermentation produces a typical beer with alcohol and unreacted solids in a water solution.

Product Recovery and Water Separation

The beer produced in fermentation is further processed in the typical distillation, dehydration, and evaporation system utilized in current alcohol product plants. A two-column distillation and dehydration is used for production of fuel grade ethanol. The ethanol is denatured by adding unleaded gasoline and the fusel oil byproduct. Water, lignin and solids are recovered from the bottom of the beer still. The solids and lignin are concentrated by evaporation into an evaporator syrup for firing in the boiler. The condensed water vapor from the evaporator is sent to waste water treatment for biogas development.

Waste Water Treatment

The water recovered from the distillation, dehydration and evaporation is treated in an anaerobic digester, aerobic digester, and clarification/filtration plant. The processed water can be recycled to the plant. A sludge byproduct is produced, which is disposed of. The anaerobic digester produces a medium BTU value off-gas that is fired in the boiler for process steam and power production.

Boiler and Cogeneration

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The boiler has several functions. It produces steam for processing needs, disposes of the concentrated evaporator syrup, and produces byproduct power. The evaporator syrup contains unconverted lignin, which can be burned to produce power and alleviate a disposal problem.

The boiler burner is multi-fuel capable with natural gas for start-up, liquid evaporator syrup for thermal oxidation of lignin and unprocessed solids, and biogas for additional energy recovery. There is sufficient energy contained in the byproduct streams to produce more steam than is needed by the process. This energy is recovered as co-generated electrical power by producing high-pressure steam and reducing the steam pressure to process conditions through a steam turbine driven generator. Sufficient power is produced to run the plant and have an excess to sell for revenue.

Utilities And Other Bulk Feed Materials

The process is supported by bulk chemical storage for process needs and other utilities. Storage for lime, ammonia, corn steep liquor, sulfuric acid, antifoam gasoline, and water treatment chemicals are provided. These various chemicals are received by rail or truck, in addition to, the truck receipt of baled dry biomass.

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D. PROCESS PLANT SUMMARY CONSTRUCTION COST ESTIMATE

There are two estimates presented here, one with onsite production of enzymes and one without. Two enzymes manufacturing companies were contacted. They both stated that large users produce their enzymes on site or very near by. Some produce them under license and some do not. For the size of this plant, on site production has cost advantages from transportation as well as logistics advantages from reduced truck traffic.

The two cost estimates are made by ratioing the equipment prices to produce the other estimate breakout costs. These ratios are based on similar work at other alcohol plants and other agricultural projects. Caution should be exercised when comparing the different ratios to other projects, to compare equivalent ratios. Special consideration should be given to the following:

- The equipment price contains subcontracted, field erected tanks costed on per gallon rates including labor. The labor split may not compare readily to other estimates.
- The true contingency rate is 25.9% of the Total Field Cost and Home Office subtotals.
- Field staff can vary according to contracting procedures
- CM Fee can generally vary between 1% and 5% depending on risks assigned to the Construction Manager. It can even be higher depending on process guarantees.
- Start-up, testing and training can vary depending on the staffing plan. Inexperienced people raise this cost.
- The contingency can be assumed to be spent on the project at this level of details for minor items not included in the equipment list, unknown equipment requirements, unknown site requirements, and other unidentified costs.

The estimate does not include offsite roads, railroads, and utility connections. These will vary according to site location.

This estimate is believed to be sufficiently accurate for the feasibility study based on the information known. It can be used to evaluate the RCBS site as well as any non-specific site.

Raytheon Engineers & Constructors

CLIENT: NYSTEC
PROJECT: 60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
LOCATION: NEW YORK
JOB NO.: 78849.001

MID AMERICA / CHICAGO OFFICE

DATE: 19-Jul-99
PRICED BY: PMF
REV. NO.:

RE&C ACCT	DESCRIPTION	MAN-HOURS	LABOR	MATERIAL	SUBS	TOTAL	% TOTAL	% TOTAL '06'	% TOTAL TFC & H.O.
01	IMPROVEMENTS TO SITE		\$505,600	\$758,400		\$1,264,000	0.5%	2.0%	0.7%
02	EARTHWORK		\$2,099,600	\$2,008,400		\$4,108,000	1.8%	6.5%	2.3%
03	CONCRETE		\$5,498,400	\$4,614,600		\$10,113,000	4.4%	16.0%	5.7%
05	STRUCTURAL STEEL		\$3,635,700	\$3,051,300		\$6,687,000	2.9%	23.0%	3.8%
06	PROCESS EQUIPMENT		\$7,021,850	\$56,184,150		\$63,206,000	27.4%	100.0%	35.5%
21	PIPING		\$15,465,000	\$13,610,000		\$29,075,000	12.6%	46.0%	16.3%
23	INSULATION		\$1,961,200	\$1,830,800		\$3,792,000	1.6%	6.0%	2.1%
24	INSTRUMENTATION & CONTROLS		\$5,169,000	\$13,793,000		\$18,962,000	8.2%	30.0%	10.7%
25	ELECTRICAL		\$6,585,600	\$4,159,400		\$10,745,000	4.7%	17.0%	6.0%
27	PAINTING		\$1,017,400	\$878,600		\$1,896,000	0.8%	3.0%	1.1%
40	BUILDINGS & ARCHITECTURAL		\$0		\$9,481,000	\$9,481,000	4.1%	15.0%	5.3%
DIRECT FIELD COST		0	\$48,959,350	\$100,888,650	\$9,481,000	\$159,329,000	69.2%	264.5%	89.6%
69	START-UP, TESTING AND TRAINING					Excluded	0.0%	0.0%	0.0%
70	TEMPORARY FACILITIES					Included Above	0.0%	0.0%	0.0%
70	CONSTRUCTION EQUIPMENT, TOOLS, SUPPLIES					Included Above	0.0%	0.0%	0.0%
71	FIELD STAFF AND LEGALITIES					\$4,677,000	2.0%	7.4%	2.6%
INDIRECT FIELD COST		0	\$0	\$0	\$0	\$4,677,000	2.0%	7.4%	2.6%
TOTAL FIELD COST		0	\$48,959,350	\$100,888,650	\$9,481,000	\$164,006,000	71.2%	271.9%	92.2%
72	ENGINEERING (HOME OFFICE)					\$13,906,000	6.0%	22.0%	7.8%
TOTAL FIELD AND HOME OFFICE						\$177,912,000	77.2%	293.9%	100.0%
TAXES (Assume Tax Exempt Project)						\$0	0.0%	0.0%	0.0%
INSURANCE						\$1,011,296	0.4%	1.6%	0.6%
PERMITS						\$94,809	0.0%	0.2%	0.1%
CRAFT CASUAL OVERTIME						\$506,000	0.2%	0.8%	0.3%
CONTINGENCY						\$46,140,000	20.0%	73.0%	25.9%
ESCALATION (Excluded)						\$0	0.0%	0.0%	0.0%
SUBTOTAL						\$225,664,105	98.0%	369.5%	126.8%
CM FEE						\$4,680,000	2.0%	7.4%	2.6%
TOTAL (CONSTRUCTION COSTS THROUGH MECHANICAL COMPLETION)						\$230,344,105	100.0%	376.9%	129.5%

Please note that the cost estimates provided herein are dependent upon the basis of the quantities and pricing utilized to develop them, and upon the underlying assumptions, inclusions, and exclusions. Actual Project costs will differ, and can significantly be affected by changes in the external environment, the manner in which the projects are implemented, and other factors which impact the basis upon which the initial estimate was prepared or otherwise affect the project. Estimate accuracy ranges are projections based upon cost estimating methods and practices in accordance with ordinary standards of care normally practiced by recognized engineering firms in performing services of a similar nature. They are not a guarantee of actual project costs.

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Raytheon Engineers & Constructors

CLIENT: NYSTEC
PROJECT: 60 MM GAL/YR BIOMASS TO ETHANOL (No Enzyme Production)
LOCATION: NEW YORK
JOB NO.: 78849.001

MID AMERICA / CHICAGO OFFICE

DATE : 19-Jul-99
PRICED BY : PMF
REV. NO. :

RE&C ACCT	DESCRIPTION	MANHOURS	LABOR	MATERIAL	SUBS	TOTAL	% TOTAL	% TOTAL '06	% TOTAL TFC & H.O.
01	IMPROVEMENTS TO SITE		\$466,000	\$699,000		\$1,165,000	0.5%	2.0%	0.7%
02	EARTHWORK		\$1,935,000	\$1,851,000		\$3,786,000	1.8%	6.5%	2.3%
03	CONCRETE		\$5,066,700	\$4,252,300		\$9,319,000	4.4%	16.0%	5.7%
05	STRUCTURAL STEEL		\$3,350,300	\$2,811,700		\$6,162,000	2.9%	23.0%	3.8%
06	PROCESS EQUIPMENT		\$6,470,850	\$51,771,150		\$58,242,000	27.4%	100.0%	35.5%
21	PIPING		\$14,250,100	\$12,540,900		\$26,791,000	12.6%	46.0%	16.3%
23	INSULATION		\$1,807,600	\$1,687,400		\$3,495,000	1.6%	6.0%	2.1%
24	INSTRUMENTATION & CONTROLS		\$4,763,100	\$12,709,900		\$17,473,000	8.2%	30.0%	10.7%
25	ELECTRICAL		\$6,068,300	\$3,832,700		\$9,901,000	4.7%	17.0%	6.0%
27	PAINTING		\$937,400	\$809,600		\$1,747,000	0.8%	3.0%	1.1%
40	BUILDINGS & ARCHITECTURAL		\$0		\$8,736,000	\$8,736,000	4.1%	15.0%	5.3%
DIRECT FIELD COST		0	\$45,115,350	\$92,965,650	\$8,736,000	\$146,817,000	69.2%	264.5%	89.6%
69	START-UP, TESTING AND TRAINING					Excluded	0.0%	0.0%	0.0%
70	TEMPORARY FACILITIES					Included Above	0.0%	0.0%	0.0%
70	CONSTRUCTION EQUIPMENT, TOOLS, SUPPLIES					Included Above	0.0%	0.0%	0.0%
71	FIELD STAFF AND LEGALITIES					\$4,310,000	2.0%	7.4%	2.6%
INDIRECT FIELD COST		0	\$0	\$0	\$0	\$4,310,000	2.0%	7.4%	2.6%
TOTAL FIELD COST		0	\$45,115,350	\$92,965,650	\$8,736,000	\$151,127,000	71.2%	271.9%	92.2%
72	ENGINEERING (HOME OFFICE)					\$12,814,000	6.0%	22.0%	7.8%
TOTAL FIELD AND HOME OFFICE						\$163,941,000	77.2%	293.9%	100.0%
	TAXES (Assume Tax Exempt Project)					\$0	0.0%	0.0%	0.0%
	INSURANCE					\$931,872	0.4%	1.6%	0.6%
	PERMITS					\$87,363	0.0%	0.2%	0.1%
	CRAFT CASUAL OVERTIME					\$466,000	0.2%	0.8%	0.3%
	CONTINGENCY					\$42,517,000	20.0%	73.0%	25.9%
	ESCALATION (Excluded)					\$0	0.0%	0.0%	0.0%
SUBTOTAL						\$207,943,235	98.0%	369.5%	126.8%
CM FEE						\$4,310,000	2.0%	7.4%	2.6%
TOTAL (CONSTRUCTION COSTS THROUGH MECHANICAL COMPLETION)						\$212,253,235	100.0%	376.9%	129.5%

Please note that the cost estimates provided herein are dependent upon the basis of the quantities and pricing utilized to develop them, and upon the underlying assumptions, inclusions, and exclusions. Actual Project costs will differ, and can significantly be affected by changes in the external environment, the manner in which the projects implemented, and other factors which impact the basis upon which the initial estimate was prepared or otherwise affect the project. Estimate accuracy ranges are projections based upon cost estimating methods and practices in accordance with ordinary standards of care normally practiced by recognized engineering firms in performing services of a similar nature. They are not a guarantee of actual project costs.

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E. PRICED EQUIPMENT LIST

The priced equipment list is comprised of extrapolation of equipment sizes and quantities from the NREL database for the simulations run; changes to the receiving, storage and processing of the biomass up to the flash vessel; changes to the alcohol fermenter size and quantity; changes to the refrigeration capacity; and changes to the boiler and steam turbine generator. The cost estimates for the changed equipment are based on vendor quotes (written and verbal), similar equipment on very recent projects, and cost-escalated estimates on less recent equipment (not more than 3 years old). There are two estimated cost columns. The first is a unit price, and the next is a quantity price.

No discounts were taken for quantity orders. The horsepower column has listed sizes that do not match standard motor sizes. These are not errors and are not special motors. These are summations of the expected connected motor horsepower around that particular piece(s) of equipment. The sum of the equipment horsepower has not been adjusted for utilization factor, so that there is a contingency, in the total applied horsepower used for power consumption, and electrical utility consumption costs.

The structures are not estimated as equipment, but shown for definition. The cost of the structures is in the different accounts of steel, concrete, etc.

This plant equipment cost can be misleading when comparisons are made on a cost per horsepower basis because of the tankage.

There are opportunities for cost reduction in the equipment in tankage and alternate equipment.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITH ENZYME FERMENTATION

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
RECEIVING, SHREDDING, & GRINDING										
2	M- 101	Biomass Truck Scale	10					\$66,000	\$132,000	AAG
3	M- 100	Bale Probe						\$8,000	\$24,000	AAG
6	M- 102	Bale Overhead Tramrail Crane	10	CS	15.75		32 ft span x 1000 lb lift x 100 ft run w/clamps, C	\$65,000	\$390,000	QUOTE
3	C- 103	48" wide Bale Belt Conveyor	10	CS	120		Flat belt conv 400 ft lg w/cont skirts & covers	\$170,000	\$510,000	ESTIMATE
3	C- 103	Bale Discharger	10	CS	6		to push 600# to 800# bale into shredder	\$5,000	\$15,000	ESTIMATE
3	M- 105	Primary Bale Shredder, 3" to 4" lumps	10	CS	750		Model ST-200EL, 43" x 96" chamber, 2,400 #	\$275,000	\$825,000	QUOTE
1	C- 106A	36" wide Shred Belt Conveyor	10	CS	20		Trough belt conv x 185 ft lg w/load skirts	\$88,000	\$88,000	ESTIMATE
1	C- 106B	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 145 ft lg w/load skirts	\$67,500	\$67,500	ESTIMATE
1	C- 106C	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 125 ft lg w/load skirts	\$59,500	\$59,500	ESTIMATE
3	M- 104	Magnets	10	SS				\$30,000	\$90,000	ESTIMATE
3	C- 107	Destoners	10	SS	9			\$40,000	\$120,000	ESTIMATE
3	M- 108	Shred Hammermill, -3/4" lumps @ 18 pcf	10	CS	750		Model HM44-48 @ 2,400 #/min, 12pcf	\$80,000	\$240,000	QUOTE
STORAGE										
3	C- 109	Pneumatic Conveying Blowers to Storage	10	CS	375		Model LS33UB, 20,200 CFM @ 17" SP	\$45,000	\$135,000	QUOTE
1	C- 110	Pneumatic Conveying Piping	10	CS			30" dia x 840 LF w/(12) 90 deg bends		INC.	ESTIMATE
3	BN- 110	Shred Storage Bins, 267,000 cu ft Capac	10	CS	24		78 ft dia x 72 ft high mild steel	\$323,000	\$969,000	QUOTE
3	S- 101	H2O Tank Filter Receiver w/ Airlock	10	CS/SS	92		20,200 CFM	\$130,000	\$390,000	ESTIMATE
3	S- 111	Shred Storage Dust Coll. w/ Airlock, Scre	10	CS	92		20,200 CFM	\$120,000	\$360,000	ESTIMATE
3	S- 111	Shred Storage Bin Cyclone Receiver w/A	10	CS	6		20,200 CFM	\$120,000	\$360,000	ESTIMATE
3	C- 111	Shred Storage Bin Internal Unloader	10	CS	304.5		Hyd, 2 speed 100,000#/hr or 67,000#/hr @ 18	\$260,000	\$780,000	QUOTE
3	C- 112	Shred Storage Reclaim Screw Convs.	10	CS	60		20" dia x 75 ft lg, 2 speed, 67,000 or 100,000#	\$25,000	\$75,000	QUOTE
3	C- 113	Pneu. Conveying Blowers to H2O Tank	10	CS	375		Model LS29UB, 20,200 CFM @ 17" SP	\$45,000	\$135,000	QUOTE
								Subtotal	\$5,765,000	
STRUCTURES										
3		Belt Conveyor Str Stl Trusses & Bents		CS			For the (3) Bale Belt Conveyors			
1		Shredders & Belt Convs Support		Precast			For the (3) Shredded Hay Belt Conveyors			
1		Support for (3) Hammermills		CS						
1		Pneu. Conv Lines Tower Support		CS			With stairway to top			
3		Hori. Truss Walkway to Storage Bins		CS			For the (3) pneumatic conveying lines			
1		Storage Bin Foundations		Reinf. Conc.			Mat fdn w/tunnels for (3) reclaim screw convs			
3		Overhead Tramrail Crane Supports		CS			To accommodate (6) tramrail cranes			
1		Weather Cover for Tramrail Cranes		CS			To cover a 100 ft x 150 ft structure			
PREHYDROLYSIS										
3	A- 203	In-Line Sulfuric Acid Mixer	20	304 SS	NA		STATIC	\$3,500	\$10,500	CORN
1	A- 215	In-Line NH3 Mixer	20	304 SS	NA		STATIC	\$3,500	\$3,500	CORN
1	P- 206	Hydrolyzate Pump	20	316 SS	50			\$40,000	\$40,000	NREL EXTRAP.

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
1	C- 209	Wash Solids Screw Conveyor	20	304 SS	20			\$62,000	\$62,000	NREL EXTRAP.
2	H- 207	Beer Column Feed Economizers	20	304 SS	NA		SHELL & TUBE	\$135,000	\$270,000	NREL EXTRAP.
1	H- 211	Hydrolyzate Cooler	20	304 SS / CS	NA		SHELL & TUBE	\$30,000	\$30,000	NREL EXTRAP.
3	T- 204D	Biomass Wetting Tank	20	304SS	NA			\$4,000	\$12,000	ESTIMATE
3	T- 204G	Prehydrolysis Reactor	20	HAST C	NA		SCREW FEEDER	\$12,000	\$36,000	ESTIMATE
3	P- 202	Sulfuric Acid Pump	20	304 SS	1		CENTRIFUGAL	\$12,000	\$36,000	NREL EXTRAP.
1	P- 210	ISEP Hydrolyzate Feed Pump	20	304 SS	50		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 213	ISEP Reload Pump	20	304 SS	30		CENTRIFUGAL	\$6,000	\$6,000	NREL EXTRAP.
1	P- 214	ISEP Elution Pump	20	304 SS	10		CENTRIFUGAL	\$5,500	\$5,500	NREL EXTRAP.
3	S- 208	Pre-IX Belt Filter Press	20	316 SS	22.5			\$1,100,000	\$3,300,000	NREL EXTRAP.
1	S- 212	ISEP	20	316 SS/ PP	NA		CONTINUOUS	\$1,400,000	\$1,400,000	NREL EXTRAP.
1	T- 216	ISEP Feed Tank	20	304SS	NA		Not shown, Part of S-208	\$6,000	\$6,000	ESTIMATE
1	T- 201	Sulfuric Acid Day Tank	20	PP	NA	3,200	GAL VERTICAL, CYLINDRICAL	\$4,000	\$4,000	NREL EXTRAP.
1	T- 206	Blowdown Tank	20	316 SS	NA	7,200	GAL VERTICAL, CYLINDRICAL	\$42,000	\$42,000	NREL EXTRAP.
		OVERLIMING						Subtotal	\$5,270,500	
1	A- 217	In-Line Acidification Mixer	21	304 SS	NA		STATIC	\$3,500	\$3,500	NREL EXTRAP.
1	A- 222	Overliming Tank Agitator	21	SS	25		FIXED PROP	\$15,000	\$15,000	NREL EXTRAP.
1	A- 225	Reacidification Tank Agitator	21	SS	100		FIXED PROP	\$22,000	\$22,000	NREL EXTRAP.
1	A- 230	Slurrying Tank Agitator	21	SS	50		FIXED PROP	\$15,000	\$15,000	NREL EXTRAP.
1	C- 219	Lime Solids Feeder	21	CS	5		ROTARY VALVE	\$1,500	\$1,500	NREL EXTRAP.
1	P- 223	Overlimed Hydrolyzate Pump	21	304 SS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 226	Reacidified Liquor Pump	21	304 SS	50		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 228	Filtered Hydrolyzate Pump	21	304 SS	75		CENTRIFUGAL	\$7,500	\$7,500	NREL EXTRAP.
3	P- 231	Fermentation Feed Pumps	21	304 SS	300		ROTARY LOBE	\$40,000	\$120,000	NREL EXTRAP.
1	S- 220	Lime Dust Vent Baghouse	21	CS/POLY	NA		FABRIC FILTER	\$32,000	\$32,000	NREL
1	S- 227	Hydroclone & Rotary Drum Filter	21	POXY LINED	5			\$110,000	\$110,000	NREL EXTRAP.
1	T- 218	Lime Storage Bin	21	CS	NA	4500	CF VERTICAL, CYLINDRICAL	\$70,000	\$70,000	NREL
1	T- 221	Overliming Tank	21	304 SS	NA	23,000	GAL VERTICAL, CYLINDRICAL	\$52,000	\$52,000	NREL EXTRAP.
1	T- 224	Reacidification Tank	21	304 SS	NA	95,000	GAL VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$100,000	\$100,000	NREL EXTRAP.
1	T- 229	Slurrying Tank	21	304 SS	NA	12,500	GAL VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$30,000	\$30,000	NREL EXTRAP.
		SEED FERMENTATION						Subtotal	\$592,500	
3	A- 308	4th Seed Fermenter Agitator	30	SS	60		FIXED PROP	\$8,000	\$24,000	NREL EXTRAP.
3	A- 309	5th Seed Fermenter Agitator	30	SS	60		FIXED PROP	\$7,000	\$21,000	NREL EXTRAP.
3	A- 322	SSCF Seed Hold Tank Agitator	30	304 SS	75		FIXED PROP	\$8,000	\$24,000	CORN
3	F- 301	1st SSCF Seed Fermenter	30	304 SS	NA	10	GAL VERTICAL, CYLINDRICAL	\$4,500	\$13,500	NREL EXTRAP.
3	F- 302	2nd SSCF Seed Fermenter	30	304 SS	NA	100	GAL VERTICAL, CYLINDRICAL	\$8,000	\$24,000	NREL EXTRAP.
3	F- 303	3rd SSCF Seed Fermenter	30	304 SS	NA	1000	GAL VERTICAL, CYLINDRICAL	\$26,000	\$78,000	NREL EXTRAP.
3	F- 304	4th SSCF Seed Fermenter	30	304 SS	NA	10,000	GAL VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$80,000	\$240,000	NREL EXTRAP.

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
3	F- 305	5th SSCF Seed Fermenter	30	304 SS	NA	100,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$150,000	\$450,000	CORN
3	H- 306	4th Seed Fermenter Coil	30	SS	NA		IMMERSED	\$2,500	\$7,500	NREL EXTRAP.
3	H- 307	5th Seed Fermenter Coil	30	SS	NA		IMMERSED	\$15,000	\$45,000	NREL EXTRAP.
3	H- 320	SSCF Seed Hydrolyzate Cooler	30	304 SS	NA		PLATE & FRAME	\$10,000	\$30,000	NREL EXTRAP.
3	P- 323	SSCF Seed Transfer Pump	30	304 SS	180		ROTARY LOBE	\$15,000	\$45,000	NREL EXTRAP.
3	P- 324	Seed Transfer Pump	30	304 SS	180		ROTARY LOBE	\$35,000	\$105,000	NREL EXTRAP.
3	T- 321	SSCF Seed Hold Tank	30	304 SS	NA	130,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$110,000	\$330,000	NREL EXTRAP.
		FERMENTATION						Subtotal	\$1,437,000	
1	A- 338	Beer Storage Tank Agitator	31	304 SS	20		FIXED PROP	\$50,000	\$50,000	NREL EXTRAP.
15	A- 300	SSCF Fermenter Agitators	31	304 SS	3000		FIXED PROP	\$50,000	\$750,000	CORN
15	F- 300	SSCF Fermenters	31	304 SS	NA	1,267,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$519,470	\$7,792,050	CORN EXTRAP.
3	H- 336	SSCF Hydrolyzate Coolers	31	304 SS	NA		PLATE & FRAME	\$16,000	\$48,000	NREL EXTRAP.
15	H- 300	Fermenter Coolers	31	304 SS	NA		INTERNAL COILS	\$50,000	\$750,000	CORN
1	P- 339	Beer Transfer Pump	31	304 SS	150		CENTRIFUGAL	\$12,000	\$12,000	NREL EXTRAP.
15	P 300	SSCF Recirculation & Transfer Pumps	31	304 SS	1125		CENTRIFUGAL	\$12,000	\$180,000	CORN
1	T- 337	Beer Storage Tank	31	304 SS	NA	8,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$24,000	\$24,000	NREL EXTRAP.
		CELLULASE SEED PRODUCTION						Subtotal	\$9,606,050	
3	F- 401	1st Cellulase Seed Fermenter	40	304 SS	NA	20 GAL	VERTICAL, CYLINDRICAL	\$4,500	\$13,500	NREL EXTRAP.
3	F- 402	2nd Cellulase Seed Fermenter	40	304 SS	NA	330 GAL	VERTICAL, CYLINDRICAL	\$26,000	\$78,000	NREL EXTRAP.
3	F- 403	3rd Cellulase Seed Fermenter	40	304 SS	NA	6,600 GAL	VERTICAL, CYLINDRICAL	\$30,000	\$90,000	NREL EXTRAP.
3	P 404	Cellulase Seed Pump	40	316 SS	1		ROTARY LOBE	\$8,000	\$24,000	NREL EXTRAP.
		CELLULASE PRODUCTION						Subtotal	\$205,500	
11	A- 421	Cellulase Fermenter Agitator	41	304 SS	5500		AXIAL IMPELLER	\$50,000	\$550,000	NREL EXTRAP.
11	F- 410	Cellulase Fermenter	41	304 SS	NA	264,000 GAL	VERTICAL, CYLINDRICAL	\$175,000	\$1,925,000	CORN EXTRAP.
11	H- 432	Cellulase Fermenter Cooler	41	304 SS	NA		IMMERSED COIL	\$23,000	\$253,000	NREL EXTRAP.
1	P- 406	Media Pump	41	SS	1		CENTRIFUGAL	\$5,500	\$5,500	NREL EXTRAP.
1	P- 408	Antifoam Pump	41	CS	1		CENTRIFUGAL	\$4,000	\$4,000	NREL EXTRAP.
1	P- 409	Cellulase Transfer Pump	41	SS	110		CENTRIFUGAL	\$6,500	\$6,500	NREL EXTRAP.
1	T- 405	Media Prep Tank	41	304 SS	NA	3,200 GAL	VERTICAL, CYLINDRICAL	\$24,000	\$24,000	NREL EXTRAP.
1	T- 407	Antifoam Tank	41	PE	NA	500 GAL	VERTICAL, CYLINDRICAL	\$2,500	\$2,500	NREL EXTRAP.
		DISTILLATION & RECTIFICATION						Subtotal	\$2,770,500	
1	D- 502	Beer Column	50	304 SS	NA		DISTILLATION	\$204,000	\$204,000	CORN
1	D- 510	Rectification Column	50	SS	NA		DISTILLATION	\$360,000	\$360,000	CORN
1	H- 501	Beer Column Feed Interchange	50	SS	NA		PLATE & FRAME	\$95,000	\$95,000	CORN
1	H- 504	Beer Column Reboiler	50	304 SS / CS	NA		SHELL & TUBE	\$165,000	\$165,000	CORN
1	H- 507	Beer Column Condenser	50	304 SS / CS	NA		SHELL & TUBE	\$137,000	\$137,000	CORN
1	H- 508	Rectification Column Reboiler	50	304 SS / CS	NA		SHELL & TUBE	\$20,000	\$20,000	CORN
1	H- 513	Rectification Column Condenser	50	304 SS / CS	NA		SHELL & TUBE	\$60,000	\$60,000	NREL EXTRAP.
1	P- 503	Beer Column Bottoms Pump	50	SS	400		CENTRIFUGAL	\$29,000	\$29,000	CORN

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
1	P- 506	Beer Column Reflux Pump	50	SS	1		CENTRIFUGAL	\$6,000	\$6,000	CORN
1	P- 509	Rectification Column Bottoms Pump	50	SS	15		CENTRIFUGAL	\$7,000	\$7,000	CORN
1	P- 512	Rectification Column Reflux Pump	50	SS	25		CENTRIFUGAL	\$6,000	\$6,000	CORN
1	P- 515	Scrubber Bottoms Pump	50	SS	5		CENTRIFUGAL	\$2,000	\$2,000	NREL EXTRAP.
1	T- 505	Beer Column Reflux Drum	50	304 SS	NA	175 GAL	HORIZONTAL, CYLINDRICAL	\$8,000	\$8,000	NREL EXTRAP.
1	T- 511	Rectification Column Reflux Drum	50	304 SS / CS	NA		HORIZONTAL, CYLINDRICAL	\$23,000	\$23,000	CORN
1	T- 514	Vent Scrubber	50	304 SS / Poly	NA		ABSORBER	\$30,000	\$30,000	CORN
		EVAPORATION & DEHYDRATION						Subtotal	\$1,152,000	
1	E- 520	1st Effect Evaporator(2)	51	316 SS			SHELL & TUBE	\$1,750,000	\$1,750,000	CORN
1	E- 525	2nd Effect Evaporator	51	316 SS			SHELL & TUBE	w / E-520A		CORN
1	E- 530	3rd Effect Evaporator(2)	51	316 SS			SHELL & TUBE	w / E-520A		CORN
1	H- 532	Evaporator Condenser	51	304 SS / CS			SHELL & TUBE	w / E-520A		CORN
3	M- 516	Molecular Sieve	51	SS				\$800,000	\$2,400,000	CORN
2	P- 521	1st Effect Pump	51	SS	500		CENTRIFUGAL	w / E-520A		CORN
1	P- 526	2nd Effect Pump	51	SS	75		CENTRIFUGAL	w / E-520A		CORN
2	P- 531	3rd Effect Pump	51	SS	100		CENTRIFUGAL	w / E-520A		CORN
1	P- 533	Evaporator Condensate Pump	51	304 SS / CS	50		CENTRIFUGAL	w / E-520A		CORN
		LIGNIN SEPARATION						Subtotal	\$4,150,000	
1	A- 604	Recycled Water Tank Agitator	60	SS	10		FIXED PROP	\$8,000	\$8,000	CORN
1	C- 602	Lignin Wet Cake Screw	60	CS	25			\$21,000	\$21,000	NREL EXTRAP.
2	P- 605	Recycled Water Pump	60	CS	120		CENTRIFUGAL	\$6,000	\$12,000	CORN
4	S- 601	Beer Column Bottoms Centrifuge	60	316 SS	320		CENTRIFUGAL	\$600,000	\$2,400,000	CORN
1	T- 603	Recycled Water Tank	60	CS	NA		VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$10,000	\$10,000	NREL EXTRAP.
		WASTE WATER TREATMENT						Subtotal	\$2,451,000	
4	A- 608	Equalization Basin Agitator	61	SS	160		FIXED PROP	\$19,000	\$76,000	NREL EXTRAP.
4	A- 613	Anaerobic Agitator	61	SS	160		FIXED PROP	\$20,000	\$80,000	NREL EXTRAP.
16	A- 617	Aerobic Lagoon Agitator	61	CS	400		SURFACE AERATOR	\$350,000	\$5,600,000	NREL EXTRAP.
1	C- 625	Aerobic Sludge Screw	61	CS	5			\$4,000	\$4,000	NRELETRAP.
1	H- 610	Anaerobic Digester Feed Cooler	61	316 SS / CS	NA		SHELL & TUBE	\$85,000	\$85,000	NREL EXTRAP.
1	M- 611	Nutrient Feed System	61	CS	5			\$22,000	\$22,000	NREL EXTRAP.
1	M- 615	Biogas Emergency Flare	61	SS	NA			\$12,000	\$12,000	NREL EXTRAP.
1	P- 609	Anaerobic Reactor Feed Pump	61	CS	30		CENTRIFUGAL	\$8,000	\$8,000	NREL EXTRAP.
1	P- 614	Aerobic Digester Feed Pump	61	CS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 618	Aerobic Digestion Outlet Pump	61	CS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 619	Aerobic Sludge Recycle Pump	61	316 SS	2		SLURRY	\$7,500	\$7,500	NREL EXTRAP.
1	P- 621	Aerobic Sludge Pump	61	316 SS	2		SLURRY	\$7,500	\$7,500	NREL EXTRAP.
1	P- 622	Treated Water Pump	61	CS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 626	Sludge Filtrate Recycle Pump	61	CS	2		CENTRIFUGAL	\$4,000	\$4,000	NREL EXTRAP.
1	S- 624	Belt Filter Press	61		30			\$75,000	\$75,000	NREL EXTRAP.

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
1	T- 607	Equalization Basin	61	CONCRETE	NA			\$225,000	\$225,000	NREL EXTRAP.
1	T- 612	Anaerobic Digester	61	POXY LINED	NA		VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$350,000	\$350,000	NREL EXTRAP.
1	T- 616	Aerobic Digester (4)	61	LYMER LINE	NA		LINED PIT	\$425,000	\$425,000	NREL EXTRAP.
1	T- 620	Clarifier	61	CONCRETE	NA			\$120,000	\$120,000	NREL EXTRAP.
		LIQUID STORAGE						Subtotal	\$7,122,000	
1	A- 703	Denaturant In-Line Mixer	70	304 SS	NA		STATIC	\$3,500	\$3,500	CORN
2	P- 702	Ethanol Product Pump	70	CS	5		CENTRIFUGAL	\$5,500	\$11,000	CORN
1	P- 705	Gasoline Pump	70	CS	2		CENTRIFUGAL	\$4,000	\$4,000	CORN
1	P- 709	Sulfuric Acid Pump	70	316 SS	1		CENTRIFUGAL	\$2,000	\$2,000	CORN
1	P- 711	Firewater Pump	70	CS	200		CENTRIFUGAL	\$16,000	\$16,000	NREL EXTRAP.
1	P- 713	Ammonia Pump	70	CS	1		CENTRIFUGAL	\$3,500	\$3,500	NREL EXTRAP.
1	P- 715	Antifoam Store Pump	70	CS	1		CENTRIFUGAL	\$4,000	\$4,000	NREL EXTRAP.
1	P- 717	CSL Pump	70	CS	5		CENTRIFUGAL	\$6,000	\$6,000	NREL EXTRAP.
1	T- 701	Ethanol Product Storage Tank	70	A285C	NA	300,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$400,000	\$400,000	CORN
1	T- 704	Gasoline Storage Tank	70	A285C	NA	60,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$95,000	\$95,000	CORN
1	T- 708	Sulfuric Acid Storage Tank	70	PP	NA	9,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$9,000	\$9,000	CORN
1	T- 710	Firewater Storage Tank	70	A285C	NA	300,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$110,000	\$110,000	NREL EXTRAP.
1	T- 712	Ammonia Storage Tank	70	A515	NA	58,000 GAL	HORIZONTAL, CYLINDRICAL	\$200,000	\$200,000	NREL EXTRAP.
1	T- 714	Antifoam Storage Tank	70	A285C	NA	12,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$12,000	\$12,000	NREL EXTRAP.
1	T- 716	CSL Storage Tank	70	304 SS	NA	36,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$60,000	\$60,000	NREL EXTRAP.
		BOILER & GENERATOR						Subtotal	\$936,000	
2	H- 803	Burner Combustion Air Preheater	80		NA			\$400,000	\$800,000	NREL EXTRAP.
2	H- 806	BFW Preheater	80	285C / A214	NA		SHELL & TUBE	\$12,000	\$24,000	NREL EXTRAP.
2	M- 801	Fluidized Bed Combustion Reactor	80	CS	NA			\$1,600,000	\$3,200,000	NREL EXTRAP.
2	M- 802	Combustion Air Fan	80	CS	500		CENTRIFUGAL	\$22,000	\$44,000	NREL EXTRAP.
1	M- 804	Turbine/Generator	80		NA			\$6,000,000	\$6,000,000	NREL EXTRAP.
2	M- 807	Combustion Gas Baghouse	80	85C / FABRI	30		FABRIC FILTER	\$500,000	\$1,000,000	NREL EXTRAP.
2	P- 805	Turbine Condensate Pump	80	CS	50		CENTRIFUGAL	\$2,000	\$4,000	NREL EXTRAP.
		BOILER FEED WATER						Subtotal	\$11,072,000	
2	M- 810	Condensate Polisher	81		NA			\$70,000	\$140,000	NREL EXTRAP.
2	M- 811	Demineralizer	81		NA			\$140,000	\$280,000	NREL EXTRAP.
1	M- 820	Hydrazine Addition Package	81		1			\$13,000	\$13,000	NREL EXTRAP.
1	M- 825	Ammonia Addition Package	81		1			\$13,000	\$13,000	NREL EXTRAP.
1	M- 830	Phosphate Addition Package	81		1			\$13,000	\$13,000	NREL EXTRAP.
2	P- 809	Condensate Pump	81	CS	20		CENTRIFUGAL	\$5,500	\$11,000	NREL EXTRAP.
2	P- 813	Deaerator Feed Pump	81	CS	15		CENTRIFUGAL	\$2,300	\$4,600	NREL EXTRAP.
2	P- 815	BFW Pump	81	CS	1200		CENTRIFUGAL	\$140,000	\$280,000	NREL EXTRAP.
2	P- 817	Blowdown Pump	81	CS	1		CENTRIFUGAL	\$3,000	\$6,000	NREL EXTRAP.
1	P- 819	Hydrazine Transfer Pump	81	CS	1		CENTRIFUGAL	\$1,500	\$1,500	NREL EXTRAP.

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
1	T- 808	Condensate Collection Tank	81	A285C			VERTICAL, CYLINDRICAL	\$4,500	\$4,500	NREL EXTRAP.
1	T- 812	Condensate Surge Drum	81	CS			HORIZONTAL, CYLINDRICAL	\$16,000	\$16,000	NREL EXTRAP.
1	T- 814	Deaerator	81	A515			HORIZONTAL, CYLINDRICAL	\$10,000	\$10,000	NREL EXTRAP.
1	T- 816	Blowdown Flash Drum	81	CS			HORIZONTAL, CYLINDRICAL	\$5,000	\$5,000	NREL EXTRAP.
1	T- 818	Hydrazine Drum	81	316 SS			VERTICAL, CYLINDRICAL	\$6,500	\$6,500	NREL EXTRAP.
CHILLED, COOLING, & PROCESS WATER								Subtotal	\$804,100	
1	M- 901	Cooling Tower System	90	IBERGLASS	150		INDUCED DRAFT	\$800,000	\$800,000	NREL EXTRAP.
1	M- 903	Chilled Water Package	90	CS	300		CENTRIFUGAL	\$250,000	\$250,000	NREL EXTRAP.
2	P- 902	Cooling Water Pump	90	CS	300		CENTRIFUGAL	\$50,000	\$100,000	
2	P- 904	Make-up Water Pump	90	CS	300		CENTRIFUGAL	\$7,000	\$14,000	NREL EXTRAP.
2	P- 906	Process Water Circulating Pump	90	CS	200		CENTRIFUGAL	\$7,500	\$15,000	NREL EXTRAP.
1	T- 905	Process Water Tank	90	CS	NA	400,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$130,000	\$130,000	NREL EXTRAP.
CIP								Subtotal	\$1,309,000	
1	M- 907	CIP System	91	CS	100			\$80,000	\$80,000	
COMPRESSED AIR										
2	M- 908	Plant Air Compressor	92	CS	300		RECIPROCATING	\$87,000	\$174,000	CORN
2	M- 911	Fermenter Air Filters	92	CS	NA		CENTRIFUGAL	\$16,000	\$32,000	NREL EXTRAP.
1	S- 909	Instrument Air Dryer	92	CS	NA			\$15,000	\$15,000	CORN
1	T- 910	Plant Air Receiver	92	CS	NA		HORIZONTAL, CYLINDRICAL	\$40,000	\$40,000	CORN
			Est. Total Hp		20,713	15,431 KW				
1		Chutes & Ducts Allowances						\$1,200,000	\$1,200,000	CORN
						Est. Misc. Plant Power	1,069 KW	Subtotal	\$1,541,000	
						Est. Total Power Usage	16,500 KW	TOTAL	\$56,184,150	

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
RECEIVING, SHREDDING, & GRINDING										
2	M- 100	Biomass Truck Scale	10					\$66,000	\$132,000	AAG
3	M- 101	Bale Probe						\$8,000	\$24,000	AAG
6	M- 102	Bale Overhead Tramrail Crane	10	CS	15.75		32 ft span x 1000 lb lift x 100 ft run w/clamps, C	\$65,000	\$390,000	QUOTE
3	C- 103	48" wide Bale Belt Conveyor	10	CS	120		Flat belt conv 400 ft lg w/cont skirts & covers	\$170,000	\$510,000	ESTIMATE
3	M- 104	Bale Discharger	10	CS	6		to push 600# to 800# bale into shredder	\$5,000	\$15,000	ESTIMATE
3	M- 105	Primary Bale Shredder, 3" to 4" lumps	10	CS	750		Model ST-200EL, 43" x 96" chamber, 2,400 #	\$275,000	\$825,000	QUOTE
1	C- 106	36" wide Shred Belt Conveyor	10	CS	20		Trough belt conv x 185 ft lg w/load skirts	\$88,000	\$88,000	ESTIMATE
1	C- 106	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 145 ft lg w/load skirts	\$67,500	\$67,500	ESTIMATE
1	C- 106	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 125 ft lg w/load skirts	\$59,500	\$59,500	ESTIMATE
3	M- 107	Magnets	10	SS				\$30,000	\$90,000	ESTIMATE
3	S- 108	Destoners	10	SS	9			\$40,000	\$120,000	ESTIMATE
3	M- 109	Shred Hammermill, -3/4" lumps @ 18 pcf	10	CS	750		Model HM44-48 @ 2,400 #/min, 12pcf	\$80,000	\$240,000	QUOTE
STORAGE										
3	C- 110	Pneumatic Conveying Blowers to Storage	10	CS	375		Model LS33UB, 20,200 CFM @ 17" SP	\$45,000	\$135,000	QUOTE
1	C- 110	Pneumatic Conveying Piping	10	CS			30" dia x 840 LF w/(12) 90 deg bends		INC.	ESTIMATE
3	T- 111	Shred Storage Bins, 267,000 cu ft Capac	10	CS	24		78 ft dia x 72 ft high mild steel	\$323,000	\$969,000	QUOTE
3	S- 101	H2O Tank Filter Receiver w/ Airlock	10	CS/SS	92		20,200 CFM	\$130,000	\$390,000	ESTIMATE
3	S- 111	Shred Storage Dust Coll. w/ Airlock, Scre	10	CS	92		20,200 CFM	\$120,000	\$360,000	ESTIMATE
3	S- 111	Shred Storage Bin Cyclone Receiver w/A	10	CS	6		20,200 CFM	\$120,000	\$360,000	ESTIMATE
3	C- 112	Shred Storage Bin Internal Unloader	10	CS	304.5		Hyd, 2 speed 100,000#/hr or 67,000#/hr @ 18	\$260,000	\$780,000	QUOTE
3	C- 113	Shred Storage Reclaim Screw Convs.	10	CS	60		20" dia x 75 ft lg, 2 speed, 67,000 or 100,000#	\$25,000	\$75,000	QUOTE
3	C- 114	Pneu. Conveying Blowers to H2O Tank	10	CS	375		Model LS29UB, 20,200 CFM @ 17" SP	\$45,000	\$135,000	QUOTE
							Subtotal		\$5,765,000	
STRUCTURES										
3		Belt Conveyor Str Stl Trusses & Bents		CS			For the (3) Bale Belt Conveyors			
1		Shredders & Belt Convs Support		Precast			For the (3) Shredded Hay Belt Conveyors			
1		Support for (3) Hammermills		CS						
1		Pneu. Conv Lines Tower Support		CS			With stairway to top			
3		Hori. Truss Walkway to Storage Bins		CS			For the (3) pneumatic conveying lines			
1		Storage Bin Foundations		Reinf. Conc.			Mat fdn w/tunnels for (3) reclaim screw convs			
3		Overhead Tramrail Crane Supports		CS			To accommodate (6) tramrail cranes			
1		Weather Cover for Tramrail Cranes		CS			To cover a 100 ft x 150 ft structure			
PREHYDROLYSIS										
3	A- 203	In-Line Sulfuric Acid Mixer	20	304 SS	NA		STATIC	\$3,500	\$10,500	CORN
1	A- 215	In-Line NH3 Mixer	20	304 SS	NA		STATIC	\$3,500	\$3,500	CORN
1	P- 206	Hydrolyzate Pump	20	316 SS	50			\$40,000	\$40,000	NREL EXTRAP.

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
1	C- 209	Wash Solids Screw Conveyor	20	304 SS	20			\$62,000	\$62,000	NREL EXTRAP.
2	H- 201	Beer Column Feed Economizers	20	304 SS	NA		SHELL & TUBE	\$135,000	\$270,000	NREL EXTRAP.
1	H- 211	Hydrolyzate Cooler	20	304 SS / CS	NA		SHELL & TUBE	\$30,000	\$30,000	NREL EXTRAP.
3	T- 202	Biomass Wetting Tank	20	304SS	NA			\$4,000	\$12,000	ESTIMATE
3	T- 202	Prehydrolysis Reactor	20	HAST C	NA		SCREW FEEDER	\$12,000	\$36,000	ESTIMATE
3	P- 201	Sulfuric Acid Pump	20	304 SS	1		CENTRIFUGAL	\$12,000	\$36,000	NREL EXTRAP.
1	P- 210	ISEP Hydrolyzate Feed Pump	20	304 SS	50		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 213	ISEP Reload Pump	20	304 SS	30		CENTRIFUGAL	\$6,000	\$6,000	NREL EXTRAP.
1	P- 214	ISEP Elution Pump	20	304 SS	10		CENTRIFUGAL	\$5,500	\$5,500	NREL EXTRAP.
3	S- 208	Pre-IX Belt Filter Press	20	316 SS	22.5			\$1,100,000	\$3,300,000	NREL EXTRAP.
1	S- 212	ISEP	20	316 SS/ PP	NA		CONTINUOUS	\$1,400,000	\$1,400,000	NREL EXTRAP.
1	T- 216	ISEP Feed Tank	20	304SS	NA			\$6,000	\$6,000	ESTIMATE
1	T- 201	Sulfuric Acid Day Tank	20	PP	NA	3,200 GAL	VERTICAL, CYLINDRICAL	\$4,000	\$4,000	NREL EXTRAP.
1	T- 203	Blowdown Tank	20	316 SS	NA	7,200 GAL	VERTICAL, CYLINDRICAL	\$42,000	\$42,000	NREL EXTRAP.
		OVERLIMING						Subtotal	\$5,270,500	
1	A- 217	In-Line Acidification Mixer	21	304 SS	NA		STATIC	\$3,500	\$3,500	NREL EXTRAP.
1	A- 222	Overliming Tank Agitator	21	SS	25		FIXED PROP	\$15,000	\$15,000	NREL EXTRAP.
1	A- 225	Reacidification Tank Agitator	21	SS	100		FIXED PROP	\$22,000	\$22,000	NREL EXTRAP.
1	A- 230	Slurrying Tank Agitator	21	SS	50		FIXED PROP	\$15,000	\$15,000	NREL EXTRAP.
1	C- 219	Lime Solids Feeder	21	CS	5		ROTARY VALVE	\$1,500	\$1,500	NREL EXTRAP.
1	P- 223	Overlimed Hydrolyzate Pump	21	304 SS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 226	Reacidified Liquor Pump	21	304 SS	50		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 228	Filtered Hydrolyzate Pump	21	304 SS	75		CENTRIFUGAL	\$7,500	\$7,500	NREL EXTRAP.
3	P- 231	Fermentation Feed Pumps	21	304 SS	300		ROTARY LOBE	\$40,000	\$120,000	NREL EXTRAP.
1	S- 220	Lime Dust Vent Baghouse	21	CS/POLY	NA		FABRIC FILTER	\$32,000	\$32,000	NREL
1	S- 227	Hydroclone & Rotary Drum Filter	21	POXY LINED	5			\$110,000	\$110,000	NREL EXTRAP.
1	T- 218	Lime Storage Bin	21	CS	NA	4500 CF	VERTICAL, CYLINDRICAL	\$70,000	\$70,000	NREL
1	T- 221	Overliming Tank	21	304 SS	NA	23,000 GAL	VERTICAL, CYLINDRICAL	\$52,000	\$52,000	NREL EXTRAP.
1	T- 224	Reacidification Tank	21	304 SS	NA	95,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$100,000	\$100,000	NREL EXTRAP.
1	T- 229	Slurrying Tank	21	304 SS	NA	12,500 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$30,000	\$30,000	NREL EXTRAP.
		FERMENTATION						Subtotal	\$592,500	
1	A- 338	Beer Storage Tank Agitator	31	304 SS	20		FIXED PROP	\$50,000	\$50,000	NREL EXTRAP.
15	A- 300	SSCF Fermenter Agitators	31	304 SS	3000		FIXED PROP	\$50,000	\$750,000	CORN
15	F- 300	SSCF Fermenters	31	304 SS	NA	1,267,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$519,470	\$7,792,050	CORN EXTRAP.
3	H- 336	SSCF Hydrolyzate Coolers	31	304 SS	NA		PLATE & FRAME	\$16,000	\$48,000	NREL EXTRAP.
15	H- 300	Fermenter Coolers	31	304 SS	NA		INTERNAL COILS	\$50,000	\$750,000	CORN
1	P- 339	Beer Transfer Pump	31	304 SS	150		CENTRIFUGAL	\$12,000	\$12,000	NREL EXTRAP.
15	P 300	SSCF Recirculation & Transfer Pumps	31	304 SS	1125		CENTRIFUGAL	\$12,000	\$180,000	CORN
1	T- 337	Beer Storage Tank	31	304 SS	NA	8,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$24,000	\$24,000	NREL EXTRAP.

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
DISTILLATION & RECTIFICATION								Subtotal	\$9,606,050	
1	D- 502	Beer Column	50	304 SS	NA		DISTILLATION	\$204,000	\$204,000	CORN
1	D- 510	Rectification Column	50	SS	NA		DISTILLATION	\$360,000	\$360,000	CORN
1	H- 501	Beer Column Feed Interchange	50	SS	NA		PLATE & FRAME	\$95,000	\$95,000	CORN
1	H- 504	Beer Column Reboiler	50	304 SS / CS	NA		SHELL & TUBE	\$165,000	\$165,000	CORN
1	H- 507	Beer Column Condenser	50	304 SS / CS	NA		SHELL & TUBE	\$137,000	\$137,000	CORN
1	H- 508	Rectification Column Reboiler	50	304 SS / CS	NA		SHELL & TUBE	\$20,000	\$20,000	CORN
1	H- 513	Rectification Column Condenser	50	304 SS / CS	NA		SHELL & TUBE	\$60,000	\$60,000	NREL EXTRAP.
1	P- 503	Beer Column Bottoms Pump	50	SS	400		CENTRIFUGAL	\$29,000	\$29,000	CORN
1	P- 506	Beer Column Reflux Pump	50	SS	1		CENTRIFUGAL	\$6,000	\$6,000	CORN
1	P- 509	Rectification Column Bottoms Pump	50	SS	15		CENTRIFUGAL	\$7,000	\$7,000	CORN
1	P- 512	Rectification Column Reflux Pump	50	SS	25		CENTRIFUGAL	\$6,000	\$6,000	CORN
1	P- 515	Scrubber Bottoms Pump	50	SS	5		CENTRIFUGAL	\$2,000	\$2,000	NREL EXTRAP.
1	T- 505	Beer Column Reflux Drum	50	304 SS	NA	175 GAL	HORIZONTAL, CYLINDRICAL	\$8,000	\$8,000	NREL EXTRAP.
1	T- 511	Rectification Column Reflux Drum	50	304 SS / CS	NA		HORIZONTAL, CYLINDRICAL	\$23,000	\$23,000	CORN
1	T- 514	Vent Scrubber	50	304 SS / Poly	NA		ABSORBER	\$30,000	\$30,000	CORN
EVAPORATION & DEHYDRATION								Subtotal	\$1,152,000	
1	E- 520	1st Effect Evaporator(2)	51	316 SS			SHELL & TUBE	\$1,750,000	\$1,750,000	CORN
1	E- 525	2nd Effect Evaporator	51	316 SS			SHELL & TUBE	w / E-520A		CORN
1	E- 530	3rd Effect Evaporator(2)	51	316 SS			SHELL & TUBE	w / E-520A		CORN
1	H- 532	Evaporator Condenser	51	304 SS / CS			SHELL & TUBE	w / E-520A		CORN
3	M- 516	Molecular Sieve	51	SS				\$800,000	\$2,400,000	CORN
2	P- 521	1st Effect Pump	51	SS	500		CENTRIFUGAL	w / E-520A		CORN
1	P- 526	2nd Effect Pump	51	SS	75		CENTRIFUGAL	w / E-520A		CORN
2	P- 531	3rd Effect Pump	51	SS	100		CENTRIFUGAL	w / E-520A		CORN
1	P- 533	Evaporator Condensate Pump	51	304 SS / CS	50		CENTRIFUGAL	w / E-520A		CORN
LIGNIN SEPARATION								Subtotal	\$4,150,000	
1	A- 604	Recycled Water Tank Agitator	60	SS	10		FIXED PROP	\$8,000	\$8,000	CORN
1	C- 602	Lignin Wet Cake Screw	60	CS	25			\$21,000	\$21,000	NREL EXTRAP.
2	P- 605	Recycled Water Pump	60	CS	120		CENTRIFUGAL	\$6,000	\$12,000	CORN
4	S- 601	Beer Column Bottoms Centrifuge	60	316 SS	320		CENTRIFUGAL	\$600,000	\$2,400,000	CORN
1	T- 603	Recycled Water Tank	60	CS	NA		VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$10,000	\$10,000	NREL EXTRAP.
WASTE WATER TREATMENT								Subtotal	\$2,451,000	
4	A- 608	Equalization Basin Agitator	61	SS	160		FIXED PROP	\$19,000	\$76,000	NREL EXTRAP.
4	A- 613	Anaerobic Agitator	61	SS	160		FIXED PROP	\$20,000	\$80,000	NREL EXTRAP.
16	A- 617	Aerobic Lagoon Agitator	61	CS	400		SURFACE AERATOR	\$350,000	\$5,600,000	NREL EXTRAP.
1	C- 625	Aerobic Sludge Screw	61	CS	5			\$4,000	\$4,000	NRELETRAP.
1	H- 610	Anaerobic Digester Feed Cooler	61	316 SS / CS	NA		SHELL & TUBE	\$85,000	\$85,000	NREL EXTRAP.
1	M- 611	Nutrient Feed System	61	CS	5			\$22,000	\$22,000	NREL EXTRAP.

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Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
1	M- 615	Biogas Emergency Flare	61	SS	NA			\$12,000	\$12,000	NREL EXTRAP.
1	P- 609	Anaerobic Reactor Feed Pump	61	CS	30		CENTRIFUGAL	\$8,000	\$8,000	NREL EXTRAP.
1	P- 614	Aerobic Digestor Feed Pump	61	CS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 618	Aerobic Digestion Outlet Pump	61	CS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 619	Aerobic Sludge Recycle Pump	61	316 SS	2		SLURRY	\$7,500	\$7,500	NREL EXTRAP.
1	P- 621	Aerobic Sludge Pump	61	316 SS	2		SLURRY	\$7,500	\$7,500	NREL EXTRAP.
1	P- 622	Treated Water Pump	61	CS	75		CENTRIFUGAL	\$7,000	\$7,000	NREL EXTRAP.
1	P- 626	Sludge Filtrate Recycle Pump	61	CS	2		CENTRIFUGAL	\$4,000	\$4,000	NREL EXTRAP.
1	S- 624	Belt Filter Press	61		30			\$75,000	\$75,000	NREL EXTRAP.
1	T- 607	Equalization Basin	61	CONCRETE	NA			\$225,000	\$225,000	NREL EXTRAP.
1	T- 612	Anaerobic Digestor	61	POXY LINED	NA		VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$350,000	\$350,000	NREL EXTRAP.
1	T- 616	Aerobic Digestor	61	LYMER LINE	NA		LINED PIT	\$425,000	\$425,000	NREL EXTRAP.
1	T- 620	Clarifier	61	CONCRETE	NA			\$120,000	\$120,000	NREL EXTRAP.
		LIQUID STORAGE						Subtotal	\$7,122,000	
1	A- 703	Denaturant In-Line Mixer	70	304 SS	NA		STATIC	\$3,500	\$3,500	CORN
2	P- 702	Ethanol Product Pump	70	CS	5		CENTRIFUGAL	\$5,500	\$11,000	CORN
1	P- 705	Gasoline Pump	70	CS	2		CENTRIFUGAL	\$4,000	\$4,000	CORN
1	P- 709	Sulfuric Acid Pump	70	316 SS	1		CENTRIFUGAL	\$2,000	\$2,000	CORN
1	P- 711	Firewater Pump	70	CS	200		CENTRIFUGAL	\$16,000	\$16,000	NREL EXTRAP.
1	P- 713	Ammonia Pump	70	CS	1		CENTRIFUGAL	\$3,500	\$3,500	NREL EXTRAP.
1	P- 715	Antifoam Store Pump	70	CS	1		CENTRIFUGAL	\$4,000	\$4,000	NREL EXTRAP.
1	P- 717	CSL Pump	70	CS	5		CENTRIFUGAL	\$6,000	\$6,000	NREL EXTRAP.
1	T- 701	Ethanol Product Storage Tank	70	A285C	NA	300,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$400,000	\$400,000	CORN
1	T- 704	Gasoline Storage Tank	70	A285C	NA	60,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$95,000	\$95,000	CORN
1	T- 708	Sulfuric Acid Storage Tank	70	PP	NA	9,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$9,000	\$9,000	CORN
1	T- 710	Firewater Storage Tank	70	A285C	NA	300,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$110,000	\$110,000	NREL EXTRAP.
1	T- 712	Ammonia Storage Tank	70	A515	NA	58,000 GAL	HORIZONTAL, CYLINDRICAL	\$200,000	\$200,000	NREL EXTRAP.
1	T- 714	Antifoam Storage Tank	70	A285C	NA	12,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$12,000	\$12,000	NREL EXTRAP.
1	T- 716	CSL Storage Tank	70	304 SS	NA	36,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$60,000	\$60,000	NREL EXTRAP.
		BOILER & GENERATOR						Subtotal	\$936,000	
2	H- 803	Burner Combustion Air Preheater	80		NA			\$400,000	\$800,000	NREL EXTRAP.
2	H- 806	BFW Preheater	80	285C / A214	NA		SHELL & TUBE	\$12,000	\$24,000	NREL EXTRAP.
2	M- 801	Fluidized Bed Combustion Reactor	80	CS	NA			\$1,600,000	\$3,200,000	NREL EXTRAP.
2	M- 802	Combustion Air Fan	80	CS	500		CENTRIFUGAL	\$22,000	\$44,000	NREL EXTRAP.
1	M- 804	Turbine/Generator	80		NA			\$6,000,000	\$6,000,000	NREL EXTRAP.
2	M- 807	Combustion Gas Baghouse	80	85C / FABR	30		FABRIC FILTER	\$500,000	\$1,000,000	NREL EXTRAP.
2	P- 805	Turbine Condensate Pump	80	CS	50		CENTRIFUGAL	\$2,000	\$4,000	NREL EXTRAP.
		BOILER FEED WATER						Subtotal	\$11,072,000	
2	M- 810	Condensate Polisher	81		NA			\$70,000	\$140,000	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITHOUT ENZYME FERMENTATION

Use, reproduction, or disclosure is subject to restrictions set forth in Contract No. DE-AC36-98-GO10337 (and Subcontract TA029/SC01) with New York State Technology Enterprise Corporation.

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
2	M- 811	Demineralizer	81		NA			\$140,000	\$280,000	NREL EXTRAP.
1	M- 820	Hydrazine Addition Package	81		1			\$13,000	\$13,000	NREL EXTRAP.
1	M- 825	Ammonia Addition Package	81		1			\$13,000	\$13,000	NREL EXTRAP.
1	M- 830	Phosphate Addition Package	81		1			\$13,000	\$13,000	NREL EXTRAP.
2	P- 809	Condensate Pump	81	CS	20		CENTRIFUGAL	\$5,500	\$11,000	NREL EXTRAP.
2	P- 813	Deaerator Feed Pump	81	CS	15		CENTRIFUGAL	\$2,300	\$4,600	NREL EXTRAP.
2	P- 815	BFW Pump	81	CS	1200		CENTRIFUGAL	\$140,000	\$280,000	NREL EXTRAP.
2	P- 817	Blowdown Pump	81	CS	1		CENTRIFUGAL	\$3,000	\$6,000	NREL EXTRAP.
1	P- 819	Hydrazine Transfer Pump	81	CS	1		CENTRIFUGAL	\$1,500	\$1,500	NREL EXTRAP.
1	T- 808	Condensate Collection Tank	81	A285C			VERTICAL, CYLINDRICAL	\$4,500	\$4,500	NREL EXTRAP.
1	T- 812	Condensate Surge Drum	81	CS			HORIZONTAL, CYLINDRICAL	\$16,000	\$16,000	NREL EXTRAP.
1	T- 814	Deaerator	81	A515			HORIZONTAL, CYLINDRICAL	\$10,000	\$10,000	NREL EXTRAP.
1	T- 816	Blowdown Flash Drum	81	CS			HORIZONTAL, CYLINDRICAL	\$5,000	\$5,000	NREL EXTRAP.
1	T- 818	Hydrazine Drum	81	316 SS			VERTICAL, CYLINDRICAL	\$6,500	\$6,500	NREL EXTRAP.
		CHILLED, COOLING, & PROCESS WATER						Subtotal	\$804,100	
1	M- 901	Cooling Tower System	90	IBERGLASS	150		INDUCED DRAFT	\$800,000	\$800,000	NREL EXTRAP.
1	M- 903	Chilled Water Package	90	CS	300		CENTRIFUGAL	\$250,000	\$250,000	NREL EXTRAP.
2	P- 902	Cooling Water Pump	90	CS	300		CENTRIFUGAL	\$50,000	\$100,000	
2	P- 904	Make-up Water Pump	90	CS	300		CENTRIFUGAL	\$7,000	\$14,000	NREL EXTRAP.
2	P- 906	Process Water Circulating Pump	90	CS	200		CENTRIFUGAL	\$7,500	\$15,000	NREL EXTRAP.
1	T- 905	Process Water Tank	90	CS	NA	400,000 GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	\$130,000	\$130,000	NREL EXTRAP.
		CIP						Subtotal	\$1,309,000	
1	M- 907	CIP System	91	CS	100			\$80,000	\$80,000	
		COMPRESSED AIR								
2	M- 908	Plant Air Compressor	92	CS	300		RECIPROCATING	\$87,000	\$174,000	CORN
2	M- 911	Fermenter Air Filters	92	CS	NA		CENTRIFUGAL	\$16,000	\$32,000	NREL EXTRAP.
1	S- 909	Instrument Air Dryer	92	CS	NA			\$15,000	\$15,000	CORN
1	T- 910	Plant Air Receiver	92	CS	NA		HORIZONTAL, CYLINDRICAL	\$40,000	\$40,000	CORN
				Est. Total Hp	14,545	10,836 KW				
1		Chutes & Ducts Allowances						\$1,200,000	\$1,200,000	CORN
				Est. Misc. Plant Power		1,069 KW		Subtotal	\$1,541,000	
				Est. Total Power Usage		11,905 KW		TOTAL	\$51,771,150	

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F. PLANT OPERATING COST ESTIMATES

There is only one plant operating cost and revenue sheet assembled with the biomass price from NREL acknowledged by Ron Robbins as reasonable (however, hay currently sells for about \$100/ton according to published data). The estimated labor costs, other overhead percentages, and chemical costs are recent values used in other projects (Fall, 1998). The selected alcohol market price was chosen to be very competitive. The costs for electricity and natural gas are subject to negotiations (see attached Internet printouts). The electrical sale price used for co-generated electricity is generally recognized as reasonable. However, Niagara Mohawk phone quoted \$0.062 for the first 450 KW, then \$0.044 per KW thereafter. Maybe it is that low, but I am skeptical about other fees and contract arrangements. Natural gas was also quoted as \$2,500 for the first 5,000 therms, then \$0.40 per therm thereafter. It becomes more reasonable to use a lot of natural gas.

The cost of enzymes are particularly troublesome. Two major enzyme companies that were contacted have not yet considered how they would supply or charge enzymes for this type of plant. They do not currently supply any similar plants. One initial response of 5 to 10 times the cost of enzymes for a grain to ethanol plant, on a cost per gallon of ethanol produced basis, indicates this plant will need to manufacture its own enzymes by buying nursery stock from some source.

This is not unusual. There are several alcohol producers that do not buy commercial enzymes for their plants. They produce their own.

The cost of operating supplies, chemicals, and lubricants will be area specific and vendor deal dependent.

The plant maintenance cost will be plant design and equipment specific. The plant is designed to control corrosion.

There are opportunities on lime costs for a small on-site limekiln, if prices are too high, as long as a near by, proper quality, limestone quarry is available.

If a well is used, the cost of water will differ.

Other agricultural processing plants have avoided landfill costs by selling their sludge.

ESTIMATED OPERATING COSTS AND REVENUES

ANNUAL OPERATING COSTS WITH ENZYME FERMENTATION

Biomass	840,000 tons/year	\$35.00 /ton (Note 1)	\$29,400,000
Labor			\$6,537,450
Operating Supplies			\$445,000
Maintenance Materials			\$1,966,200
Lubricants			\$10,000
Laboratory Chemicals			\$96,000
Operating Chemicals			
H2SO4	4,170 pounds/hr	\$0.03	\$108
Lime	1,764 pounds/hr	\$75.00	\$555,660
NH3	1,530 pounds/hr	\$0.11	\$1,349,460
CSL	2 tons/hr	\$25.00	\$434,910
Nutrients	383 pounds/hr	\$0.12	\$47
NH4SO4	863 pounds/hr	\$0.02	\$19
Antifoam	12 pounds/hr	\$0.24	\$24,192
Gasoline	369 gal/hr	\$0.60	\$1,859,760
Water	257 cu.ft./hr	\$0.67	\$1,446,396
Natural Gas	100 therms/hr	\$1.86	\$1,562,400
BFW Chemicals	2 pounds/hr	\$0.97	\$17,926
CW Chemicals	11 pounds/hr	\$1.00	\$92,400
WWT Nutrients	495 pounds/hr	\$0.11	\$457,380
WWT Chemicals	2 pounds/hr	\$2.50	\$34,230
NAOH	110 pounds/hr	\$0.17	\$152,460
H3PO4	22 pounds/hr	\$0.37	\$68,376
H2O2	44 pounds/hr	\$0.50	\$182,952
Cellobiase	750 pounds/yr	\$150.00	\$112,500 *
Cellulase	750 pounds/yr	\$150.00	\$112,500 *
Landfill	3,735 pounds/hr	\$0.01	\$313,740
TOTAL COSTS			\$47,232,067

ANNUAL OPERATING REVENUES

Alcohol	60,000,000 gal/yr	\$1.35 per gal	\$81,000,000
Electrical	12,932 kw/hr	\$0.035 /kwh	\$3,802,008
TOTAL REVENUES			\$84,802,008

CASH FLOW \$37,569,941

* These are estimates of feed stock replenishment costs.

Note 1: Hay sells for \$100/ton as documented in New York Agricultural Statistics, 1997-1998.

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New York State and Local Tax Incentives for Manufacturers

A Brief Description

New York State does not tax **Inventory and Tangible Personal Property** (Machinery & Equipment). The **NYS Corporate Franchise Tax** is being reduced from 9% to 7.5% beginning July, 1999. Manufacturers are eligible to receive a 5% **Investment Tax Credit**, based on their investments in real estate and production machinery, which would greatly reduce this tax payable. To make Upstate New York even more attractive to manufacturers, the **Alternative Minimum Tax** is being reduced from 3.5% to 3% beginning July, 1999. Depending on the amount of the manufacturer's investment and the community where the investment is made (reference Economic Development Zone section), the **Investment Tax Credits** could reduce the manufacturer's obligation to the **alternative minimum rate**.

NYS Sales Tax is 4% on retail sale of tangible personal property. Many local governments add 3% for a total of 7%. **Machinery, equipment, tools, parts and supplies for manufacturing are exempt from this tax.** Building materials for constructing a manufacturing or distribution facility can be exempted via an Industrial Development Agency (IDA).

Tax Exempt Financing for capital costs associated with production property and equipment is also available from Industrial Development Agencies (IDAs).

Property Taxes are levied by local governments to fund services and schools. Industrial Development agencies can exempt manufacturers building new facilities from property taxes for periods of 10-20 years. A Payment in Lieu of Tax (**PILOT**) agreement is arranged which results in payments to support local government and schools during the period. These payments are usually significantly less for the manufacturer than the property tax would be.



ECONOMIC DEVELOPMENT ZONE BENEFITS

Electric Rate Discounts

Niagara Mohawk provides the deepest discounts for business attraction and expansion in a New York State-designated Economic Development Zone. New businesses, creating new electric load are eligible to receive 10 years of deep discounts. Current Economic Development Zone Rates (EDZR) provide discounts ranging from 50-70% off standard tariff rates.

Basic Eligibility Criteria

- Open to all non-residential customers
- Customer must receive and maintain local and state EDZ certification
- Discounts apply only to "incremental" (new to Niagara Mohawk) electricity
- Customer must be current in their payments to Niagara Mohawk
- Customer must become certified and approach Niagara Mohawk within 6 months expanding or locating in an Economic Development Zone

Existing customers of Niagara Mohawk must increase their usage in order to receive discounts:

- Electric demand customers must increase their demand by the lessor of 100kW or 25 percent of existing demand
- Electric non-demand customers must increase their usage (kWh) by at least 25 percent

A business is not eligible for discounts, if:

- It is a "New businesses" created by simple change in ownership
- You are a customer moving into an EDZ from elsewhere in Niagara Mohawk's service territory
- You have non-permanent increases in electric consumption (e.g. construction service, increased seasonal heating/cooling usage)

NOTE: Discounts on gas and telephone rates are also available in Economic Development Zones.

Other Economic Development Zone Benefits	
Investment Tax Credits (ITC) Available to manufacturers investing in production property and/or equipment, industrial waste treatment facilities, air pollution control facilities or research and development property. <i>---10% ITC for corporations</i> <i>---8% ITC for individuals</i>	Employment Incentive Credit (EIC) Available to businesses who have received the EDZ ITC and have increased employment (must be 101% of the average number of employees in the year before the ITC was claimed). <i>---30% of the EDZ ITC for up to 3 consecutive years</i>
Wage Tax Credit (WTC) Available to businesses which hire new employees. Credit is for a 5-year term, beginning with the first tax year in which EDZ wages are paid. <i>---\$1,500 for *targeted employees paid at least 135% of minimum wage</i> <i>---\$750 for all other employees</i>	WTC and ITC Refunds Generally available to new businesses less than four years old or new to New York state and eligible for WTC and/or ITC. <i>---50% Cash Refund or Eligible WTC and/or ITC</i>
NOTE: Targeted employees are individuals hired from public assistance rolls, dislocated workers and other disadvantaged individuals.	

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G. PLANT LABOR ESTIMATE

The plant crewing was assembled on the basis of other projects and special needs for this proposed plant. Of special note are the Logistic Supervisors. Based on previous experience and recent literature, these people will be in the interface with the farmers for securing the biomass. There are four (4) of them to take on quadrants of the surrounding area. They will need to locate the suppliers, possibly negotiate the contracts, and establish the supply schedule for the materials. Continuous follow-up will be required to ensure smooth feedstock supply to the plant.

The crewing is based on seven (7) day rotating shifts with two (2) days off between shifts. Other combinations are possible. Additional maintenance crewing may be needed from time to time for specialty repairs or outages. The crane operators only work two shifts. Shift supervisors manage their own maintenance crew with oversight of the maintenance supervisor. Either the operations managers or some other manager assumes duties of assistant plant manager

ESTIMATED PLANT LABOR COST WITH ENZYME PRODUCTION

Staffing	No. of People	Rate (W2)	Salary	Cost w/benefits 1.23
Plant Manager	1	\$ 62.50	\$125,000	\$153,750
Secretary	1	\$ 20.00	\$40,000	\$49,200
Human Resources Manager	1	\$ 40.00	\$80,000	\$98,400
Clerk	1	\$ 25.00	\$50,000	\$61,500
Accounting Manager	1	\$ 45.00	\$90,000	\$110,700
Clerk	1	\$ 15.00	\$30,000	\$36,900
Check Writer	1	\$ 20.00	\$40,000	\$49,200
Senior Plant Engineer	1	\$ 40.00	\$80,000	\$98,400
Plant Engineer	1	\$ 35.00	\$70,000	\$86,100
QC Manager	1	\$ 45.00	\$90,000	\$110,700
Senior Chemist	1	\$ 35.00	\$70,000	\$86,100
Chemists	4	\$ 25.00	\$200,000	\$246,000
Utility	4	\$ 15.00	\$120,000	\$147,600
Procurement Manager	1	\$ 35.00	\$70,000	\$86,100
Logistics Manager	1	\$ 55.00	\$110,000	\$135,300
Supervisors	4	\$ 35.00	\$280,000	\$344,400
Clerks	2	\$ 15.00	\$60,000	\$73,800
Shipping & Receiving Manager	1	\$ 35.00	\$70,000	\$86,100
Guards	8	\$ 20.00	\$320,000	\$393,600
Shipping & Receiving Utility	2	\$ 20.00	\$80,000	\$98,400
Operations Manager	1	\$ 55.00	\$110,000	\$135,300
Shift Supervisors	4	\$ 30.00	\$240,000	\$295,200
Control Room Operators	8	\$ 25.00	\$400,000	\$492,000
Licensed Boiler Operators	4	\$ 30.00	\$240,000	\$295,200
Utilities	4	\$ 15.00	\$120,000	\$147,600
Crane Operators	16	\$ 20.00	\$640,000	\$787,200
WWT operators	4	\$ 20.00	\$160,000	\$196,800
Maintenance Supervisor	1	\$ 45.00	\$90,000	\$110,700
Mechanical	4	\$ 30.00	\$240,000	\$295,200
Welders	4	\$ 30.00	\$240,000	\$295,200
Electrical	4	\$ 30.00	\$240,000	\$295,200
Utilities	4	\$ 20.00	\$160,000	\$196,800
Enzyme Operators	4	\$ 25.00	\$200,000	\$246,000
Samplers	2	\$ 20.00	\$80,000	\$98,400
Weighers	2	\$ 20.00	\$80,000	\$98,400
Totals	104	\$ 25.55	\$5,315,000	\$6,537,450

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ESTIMATED PLANT LABOR COST WITHOUT ENZYME PRODUCTION

Staffing	No. of People	Rate (W2)	Salary	Cost w/benefits 1.23
Plant Manager	1	\$ 62.50	\$125,000	\$153,750
Secretary	1	\$ 20.00	\$40,000	\$49,200
Human Resources Manager	1	\$ 40.00	\$80,000	\$98,400
Clerk	1	\$ 25.00	\$50,000	\$61,500
Accounting Manager	1	\$ 45.00	\$90,000	\$110,700
Clerk	1	\$ 15.00	\$30,000	\$36,900
Check Writer	1	\$ 20.00	\$40,000	\$49,200
Senior Plant Engineer	1	\$ 40.00	\$80,000	\$98,400
Plant Engineer	1	\$ 35.00	\$70,000	\$86,100
QC Manager	1	\$ 45.00	\$90,000	\$110,700
Senior Chemist	1	\$ 35.00	\$70,000	\$86,100
Chemists	4	\$ 25.00	\$200,000	\$246,000
Utility	4	\$ 15.00	\$120,000	\$147,600
Procurement Manager	1	\$ 35.00	\$70,000	\$86,100
Logistics Manager	1	\$ 55.00	\$110,000	\$135,300
Supervisors	4	\$ 35.00	\$280,000	\$344,400
Clerks	2	\$ 15.00	\$60,000	\$73,800
Shipping & Receiving Manager	1	\$ 35.00	\$70,000	\$86,100
Guards	8	\$ 20.00	\$320,000	\$393,600
Shipping & Receiving Utility	2	\$ 20.00	\$80,000	\$98,400
Operations Manager	1	\$ 55.00	\$110,000	\$135,300
Shift Supervisors	4	\$ 30.00	\$240,000	\$295,200
Control Room Operators	8	\$ 25.00	\$400,000	\$492,000
Licensed Boiler Operators	4	\$ 30.00	\$240,000	\$295,200
Utilities	4	\$ 15.00	\$120,000	\$147,600
Crane Operators	16	\$ 20.00	\$640,000	\$787,200
WWT operators	4	\$ 20.00	\$160,000	\$196,800
Maintenance Supervisor	1	\$ 45.00	\$90,000	\$110,700
Mechanical	4	\$ 30.00	\$240,000	\$295,200
Welders	4	\$ 30.00	\$240,000	\$295,200
Electrical	4	\$ 30.00	\$240,000	\$295,200
Utilities	4	\$ 20.00	\$160,000	\$196,800
Totals	96	\$ 25.81	\$4,955,000	\$6,094,650

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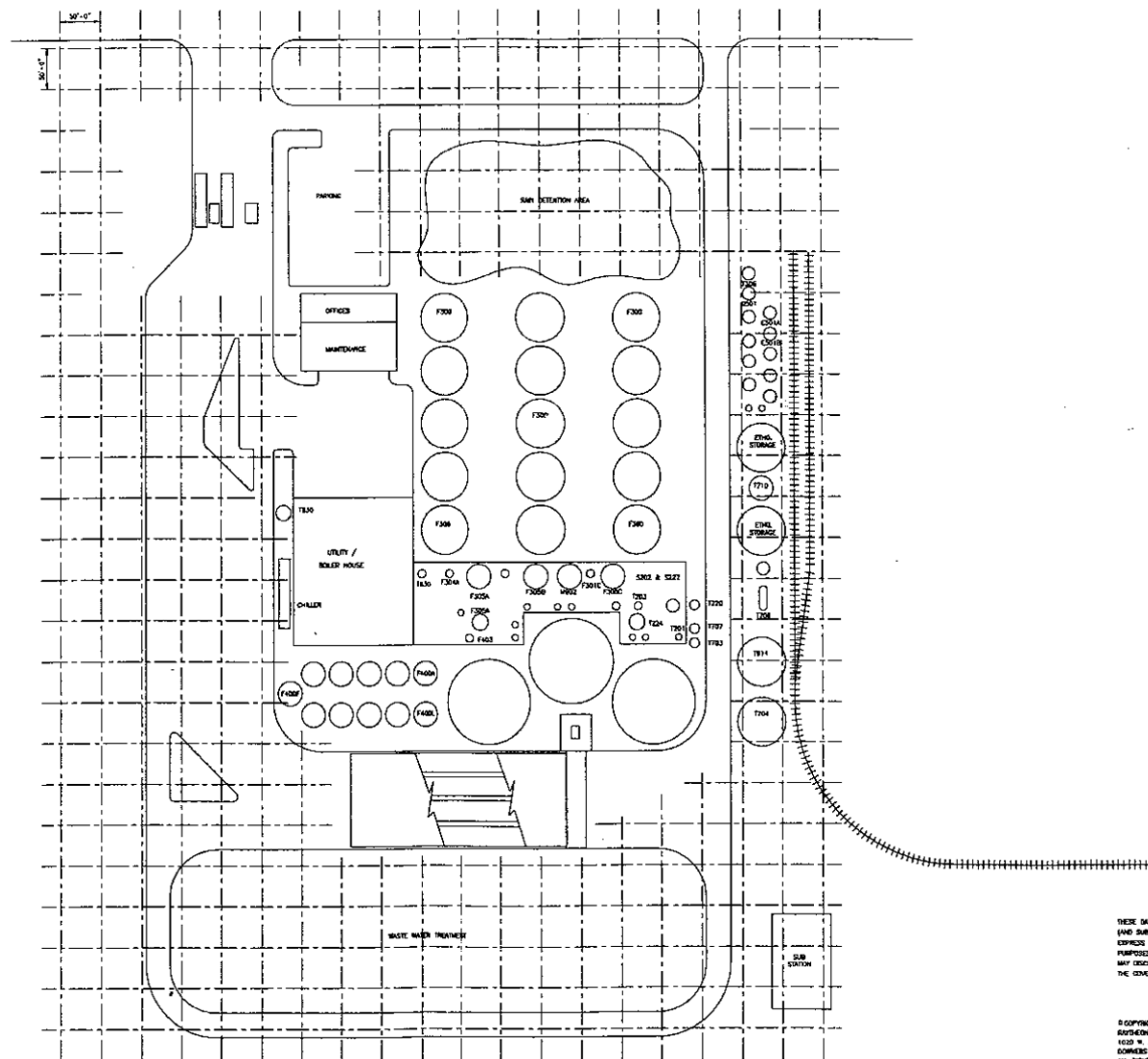
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H. CONCEPTUAL PLANT LAYOUT

This is a non-site specific plant layout. The plant layout could be utilized for the Robbins Corn and Bulk Service. Even though there is a north arrow on the drawing, there are no established criteria for the orientation. No equipment specific layout has been undertaken to establish the size of the buildings. Building size is based on previous experience and the information available in the NREL study.



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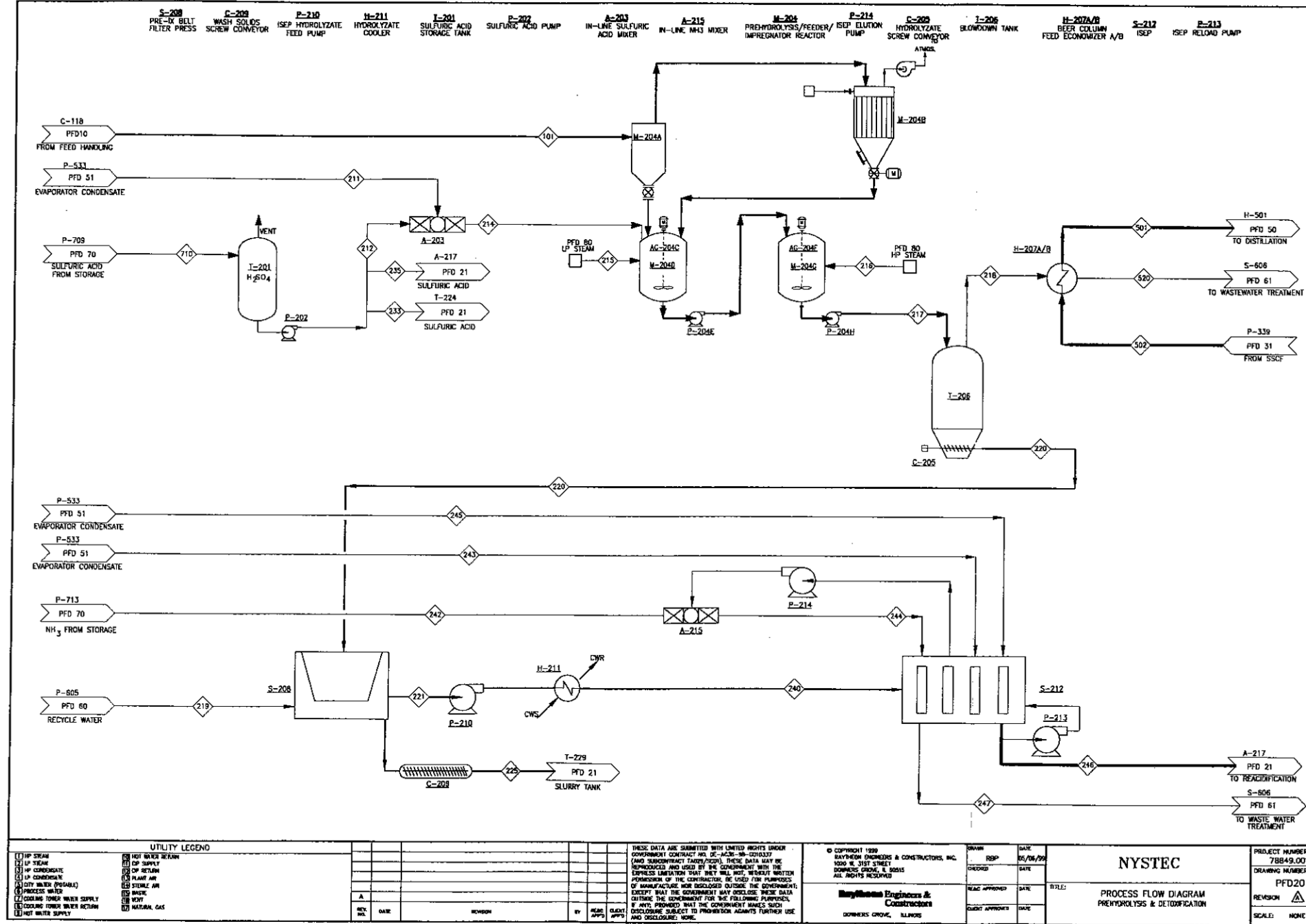
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I. PROCESS FLOW DIAGRAMS

These are the related process flow diagrams. Physical depictions of process equipment are not necessarily accurately represented.

PFD10 – Feed Handling
PFD20 – Prehydrolysis & Detoxification
PFD21 – Lime Addition
PFD30 – SSCF Seed Fermentation
PFD31 – SSCF Production Fermentation
PFD40 – Cellulase Seed Fermentation
PFD41 – Cellulase Production Fermentation
PFD50 – Beer & Rectification Distillation
PFD51 – Evaporation & Ethanol Dehydration
PFD60 – Lignin Separation and Recycle
PFD61 – Anaerobic & Aerobic Digestion
PFD70 – Liquid Storage
PFD80 – Combustor and Turbo Generator
PFD81 – Boiler Feed Water Preparation & Chemicals
PFD90 – Cooling Water, Chilled Water, Process Water, CIP System
PFD91 – CIP System
PFD92 – Plant/Instrument Air & Fermentation Air

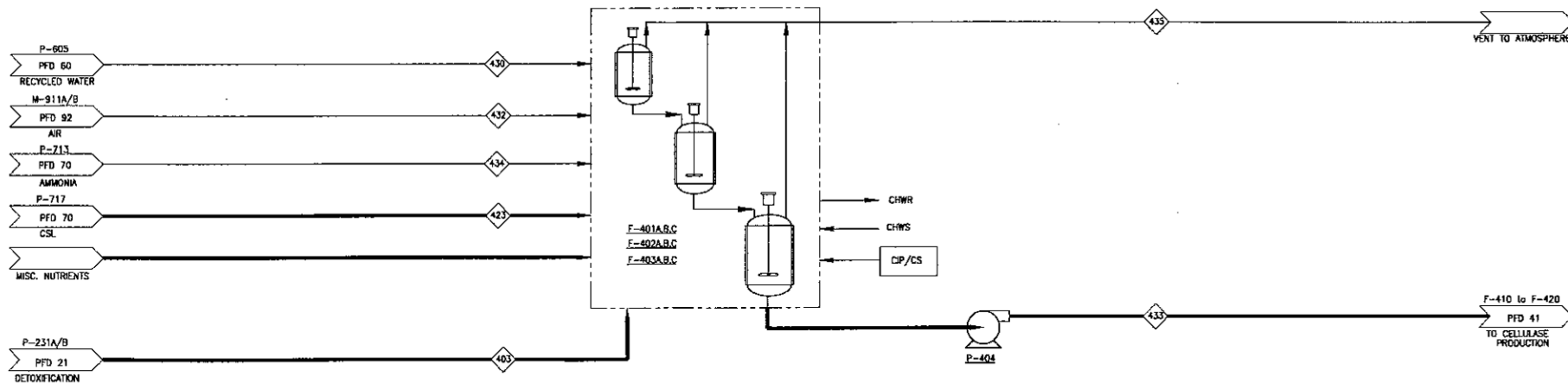


F-401A,B,C
1ST CELLULOSE
SEED FERMENTER A,B,C

F-402A,B,C
2ND CELLULOSE
SEED FERMENTER A,B,C

F-403A,B,C
3RD CELLULOSE
SEED FERMENTER A,B,C

P-404
CELLULOSE SEED PUMP



UTILITY LEGEND

- | | |
|-------------------------------|----------------------|
| 1) HP STEAM | 15) HOT WATER RETURN |
| 2) LP STEAM | 16) CIP SUPPLY |
| 3) HP CONDENSATE | 17) CIP RETURN |
| 4) LP CONDENSATE | 18) PLANT AIR |
| 5) CITY WATER (TREATED) | 19) CHEMICAL AIR |
| 6) PROCESS WATER | 20) WASTE |
| 7) COOLING TOWER WATER SUPPLY | 21) VENT |
| 8) COOLING TOWER WATER RETURN | 22) NATURAL GAS |
| 9) HOT WATER SUPPLY | |

REV. NO.

DATE

REVISION

BY

READ

APP'D

DATE

BY

READ

APP'D

DATE

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DESIGNED	DATE
CHECKED	DATE
REVIEW APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

PROCESS FLOW DIAGRAM
CELLULOSE SEED FERMENTATION

PROJECT NUMBER
75049.001

DRAWING NUMBER
PFD40

REVISION
A

SCALE
NONE

F-300
15 SSCF FERMENTERS

A-300
15 SSCF FERMENTER
AGITATORS

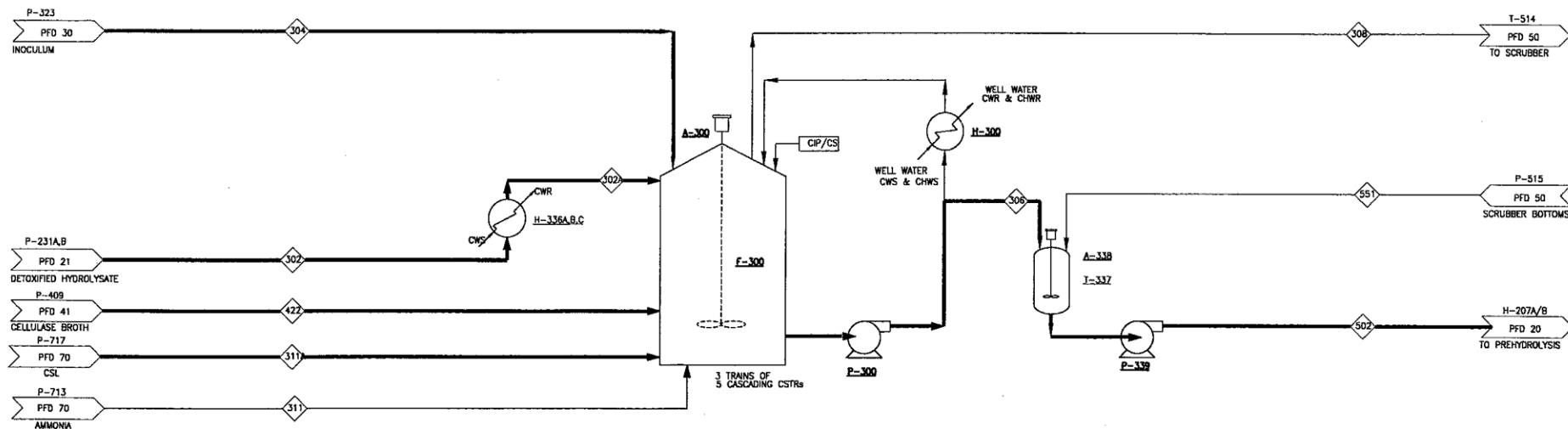
P-300
15 SSCF RECIRCULATION
& TRANSFER PUMPS

H-300
15 FERMENTER
COOLERS

T-337
BEER STORAGE TANK

A-338
BEER STORAGE
TANK AGITATOR

P-339
BEER TRANSFER PUMP



UTILITY LEGEND

(1) HP STEAM	(10) HOT WATER RETURN
(2) LP STEAM	(11) CP SUPPLY
(3) HP CONDENSATE	(12) CP RETURN
(4) LP CONDENSATE	(13) PLANT AIR
(5) CITY WATER (POURABLE)	(14) STEAM/ AIR
(6) PROCESS WATER	(15) WASTE
(7) COOLING TOWER WATER SUPPLY	(16) WWT
(8) COOLING TOWER WATER RETURN	(17) NATURAL GAS
(9) HOT WATER SUPPLY	

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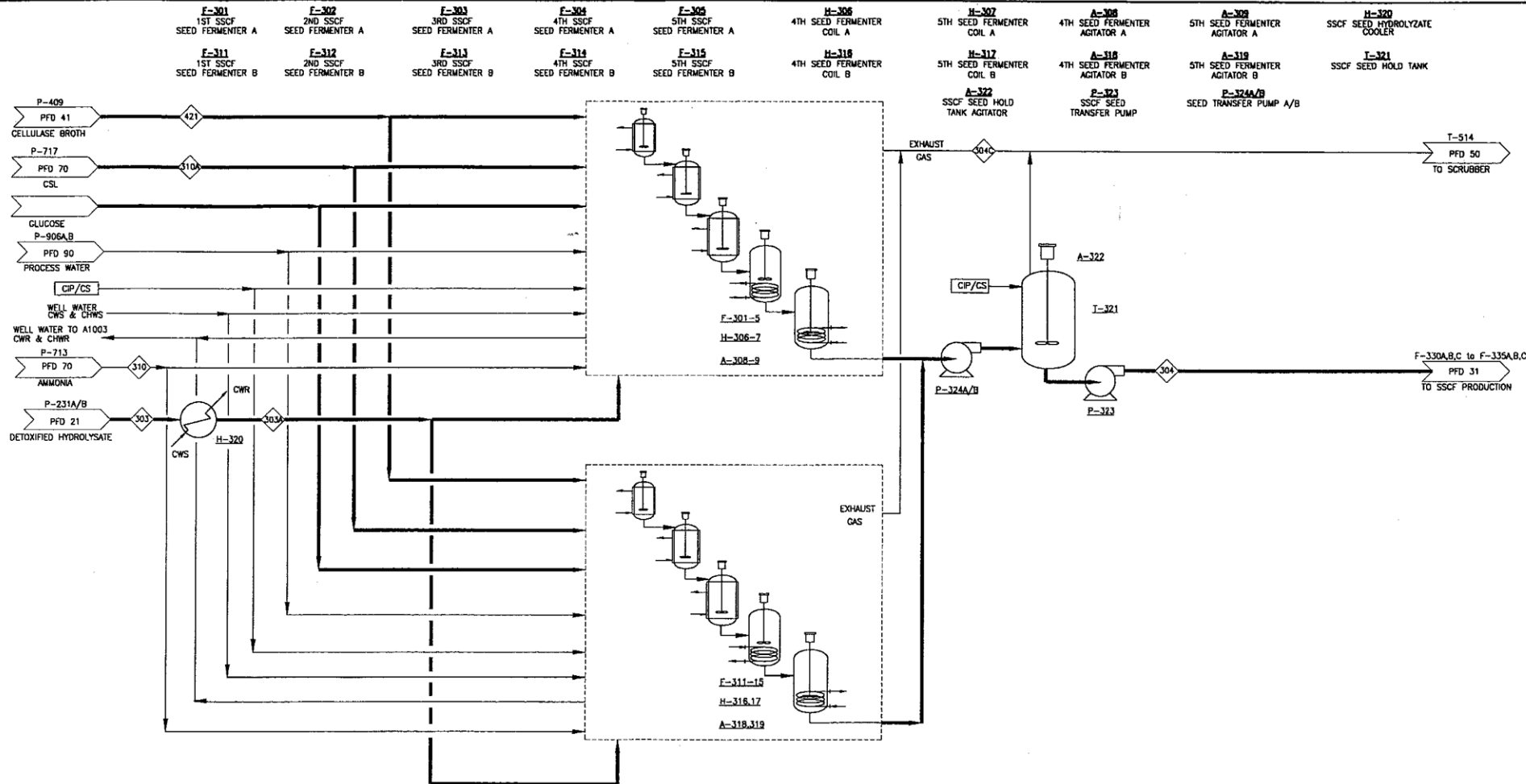
Raytheon Engineers & Constructors
DOWNEY GROVE, ILLINOIS

DATE	DATE
05/11/89	
DATE	DATE
DATE	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
SSCF PRODUCTION FERMENTATION

PROJECT NUMBER
78849.001
DRAWING NUMBER
PFD31
REVISION
SCALE: NONE



UTILITY LEGEND				REVISION				BY				DATE			
1	HP STEAM	10	HOT WATER RETURN												
2	LP STEAM	11	CIP SUPPLY												
3	HP CONDENSATE	12	CIP RETURN												
4	LP CONDENSATE	13	PLANT AIR												
5	CITY WATER (POTABLE)	14	STEAM AIR												
6	PROCESS WATER	15	WASTE												
7	COOLING TOWER WATER SUPPLY	16	WWT												
8	COOLING TOWER WATER RETURN	17	NATURAL GAS												
9	HOT WATER SUPPLY														

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DOWNERS GROVE, ILLINOIS

DESIGNED	DATE
CHKD	DATE
REAC APPROVED	DATE
CLIENT APPROVED	DATE

PROJECT NUMBER	78849.001
DRAWING NUMBER	PFD30
REVISION	△
SCALE	NONE

NYSTEC

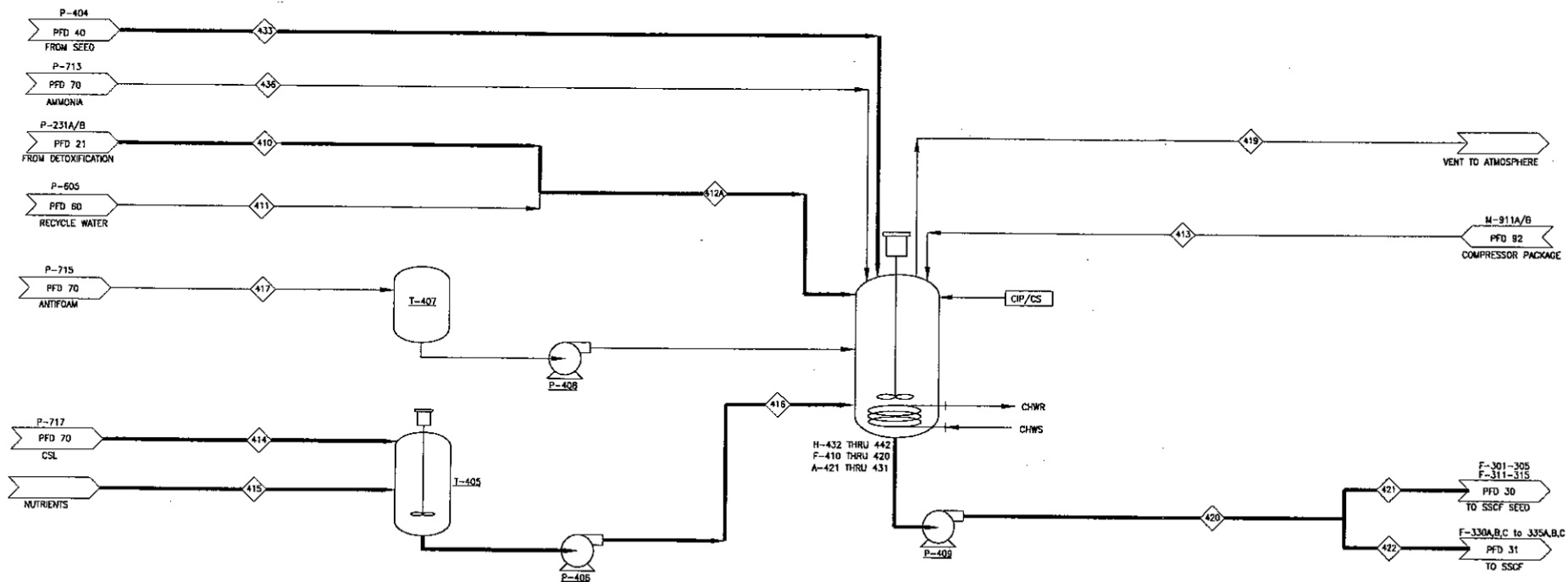
PROCESS FLOW DIAGRAM
SSF SEED FERMENTATION

T-405
 MEDIA PREP. TANK
F-410
 CELLULOSE FERMENTERS

P-406
 MEDIA PUMP
A-421
 CELLULOSE FERMENTER AGITATORS

T-407
 ANTIFOAM TANK
H-432
 CELLULOSE FERMENTER COOLERS

P-408
 ANTIFOAM PUMP
P-409
 CELLULOSE TRANSFER PUMP



UTILITY LEGEND

1) HP STEAM	10) HOT WATER RETURN
2) LP STEAM	11) CIP SUPPLY
3) HP CONDENSATE	12) CIP RETURN
4) LP CONDENSATE	13) PLANT AIR
5) CITY WATER (POTABLE)	14) STORM AIR
6) PROCESS WATER	15) WASTE
7) COOLING TOWER WATER SUPPLY	16) VENT
8) COOLING TOWER WATER RETURN	17) NATURAL GAS
9) HOT WATER SUPPLY	

REV	DATE	REVISION	BY	REAC	APPD	DATE
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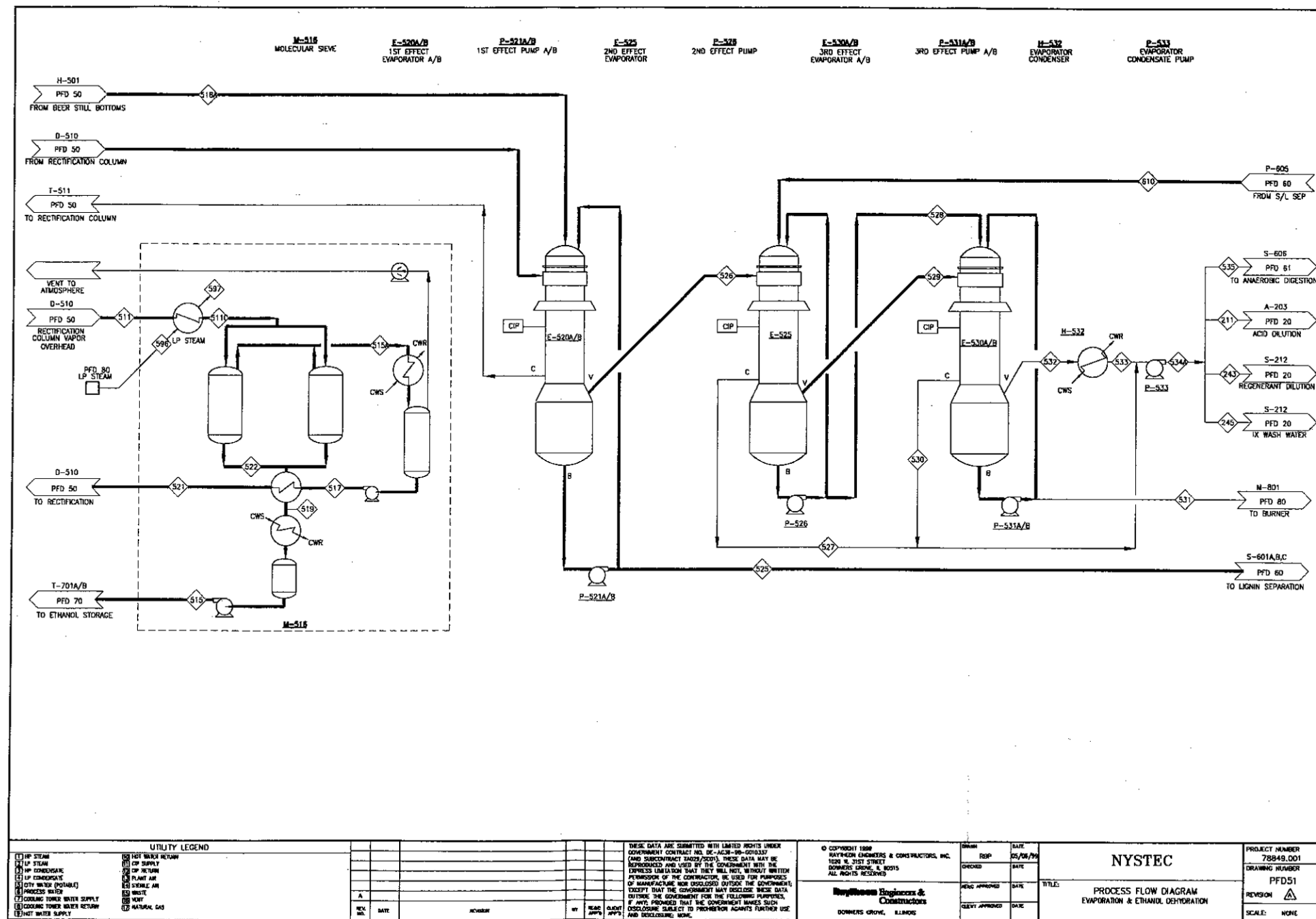
Raymond Engineers & Constructors
 DOWNERS GROVE, ILLINOIS

DATE	REVISION	DATE
05/11/89		

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD41
REVISION A
SCALE: NONE

NYSTEC

TITLE:
 PROCESS FLOW DIAGRAM
 CELLULOSE PRODUCTION FERMENTATION



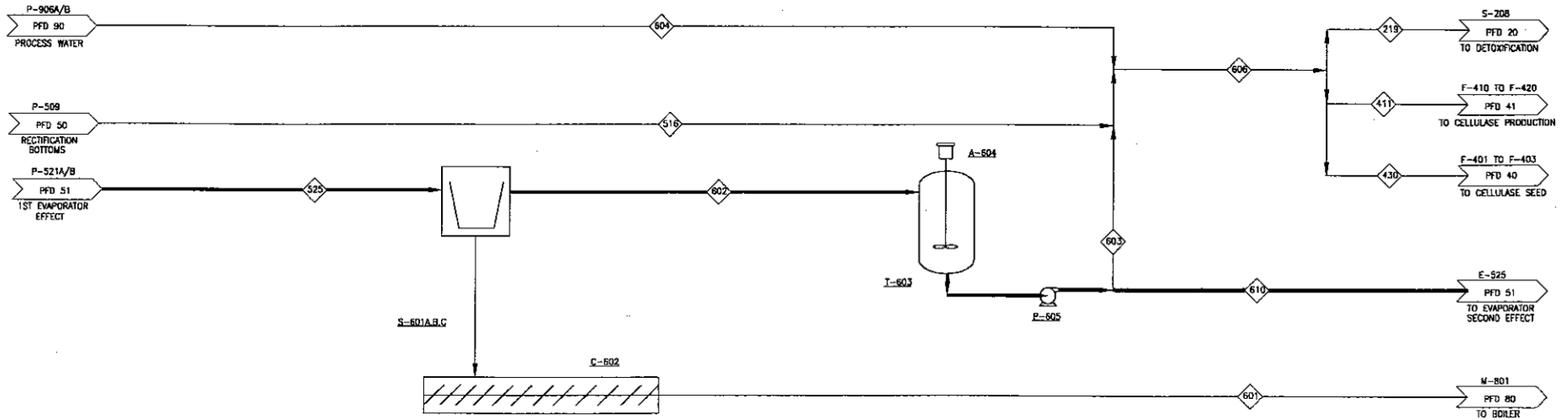
S-501A/B/C
BEER COLUMN
BOTTOMS CENTRIFUGE A/B/C

C-502
LIGNIN WET
CAKE SCREW

T-503
RECYCLED WATER TANK

A-504
RECYCLED WATER
TANK AGITATOR

P-505
RECYCLED WATER PUMP



UTILITY LEGEND

1) HP STEAM	10) HOT WATER RETURN
2) LP STEAM	11) CP SUPPLY
3) HP CONDENSATE	12) CP RETURN
4) LP CONDENSATE	13) PLANT AIR
5) CITY WATER (POURABLE)	14) STEAM AIR
6) PROCESS WATER	15) WASTE
7) COOLING TOWER WATER SUPPLY	16) VENT
8) COOLING TOWER WATER RETURN	17) NATURAL GAS
9) HOT WATER SUPPLY	

REV. NO.

DATE

REVISION

BY

NAME

APPD

CLIENT

APPD

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DRAWN
CHECKED
NAME APPROVED
DATE

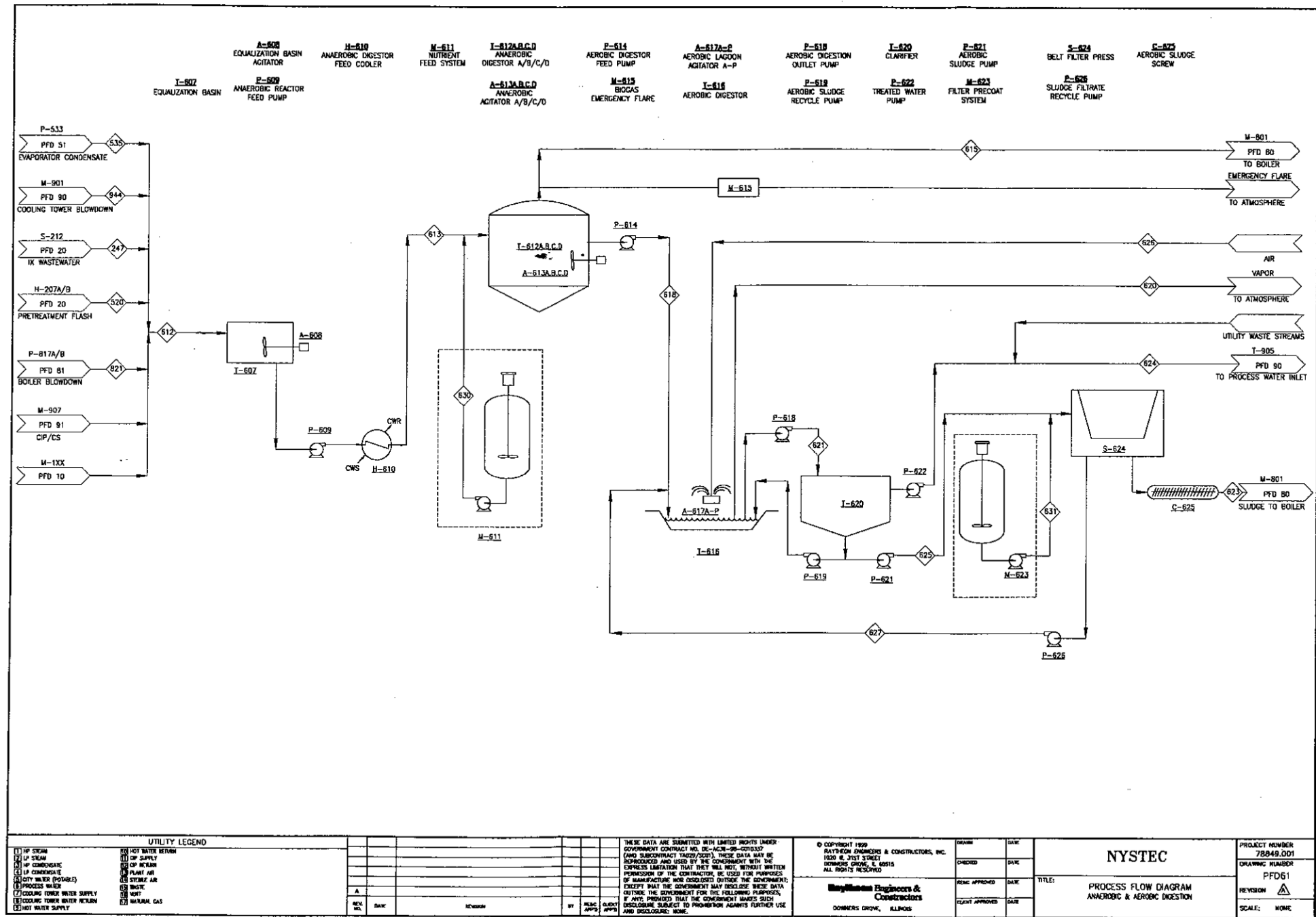
DATE
DATE
DATE

TITLE:

NYSTEC

PROCESS FLOW DIAGRAM
LIGNIN SEPARATION AND RECYCLE

PROJECT NUMBER
79849.001
DRAWING NUMBER
PFD50
REVISION
SCALE: NONE



I-701A/B
ETHANOL PRODUCT
STORAGE TANK A/B

P-702A/B
ETHANOL PRODUCT
PUMP A/B

A-703
DENATURANT
IN-LINE MIXER

I-704
GASOLINE
STORAGE TANK

P-705
GASOLINE
PUMP

I-708
SULFURIC ACID
STORAGE TANK

P-709
SULFURIC ACID
PUMP

I-710
FIREWATER
STORAGE TANK

P-711
FIREWATER
PUMP

I-712
AMMONIA
STORAGE TANK

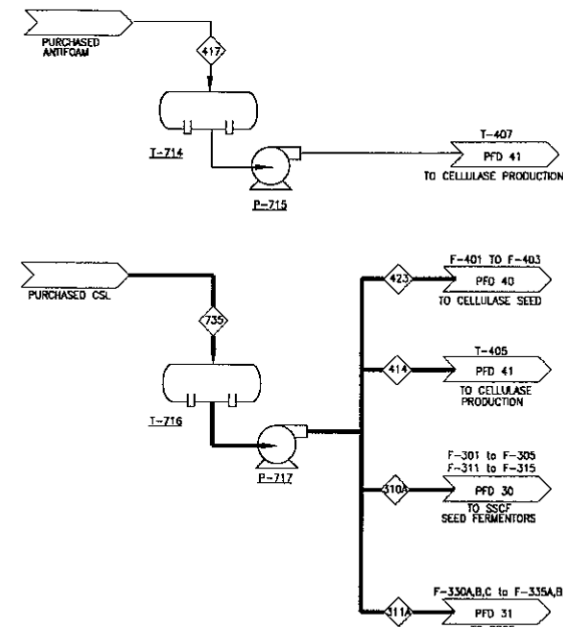
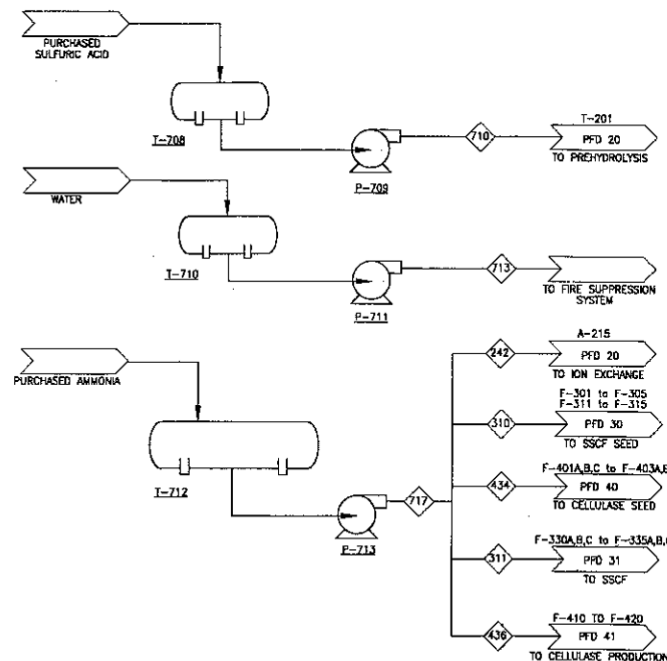
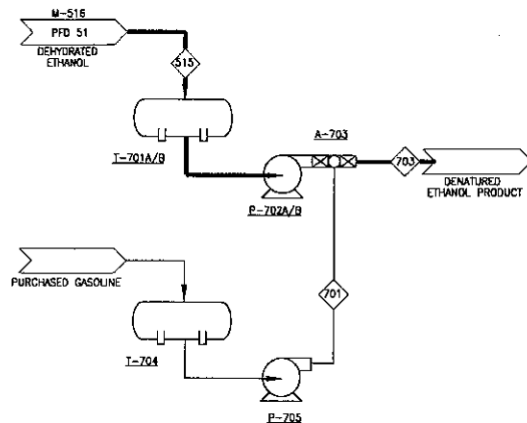
P-713
AMMONIA
PUMP

I-714
ANTIFOAM
STORAGE TANK

P-715
ANTIFOAM
STORE PUMP

I-716
CSL
STORAGE TANK

P-717
CSL
PUMP



UTILITY LEGEND

- | | |
|--------------------------------|-----------------------|
| (1) HP STEAM | (10) HOT WATER RETURN |
| (2) LP STEAM | (11) COP SUPPLY |
| (3) HP CONDENSATE | (12) COP RETURN |
| (4) LP CONDENSATE | (13) PLANT AIR |
| (5) CITY WATER (POTABLE) | (14) STORE AIR |
| (6) PROCESS WATER | (15) WASTE |
| (7) COOLING TOWER WATER SUPPLY | (16) WWT |
| (8) COOLING TOWER WATER RETURN | (17) NATURAL GAS |
| (9) HOT WATER SUPPLY | |

REV	DATE	REVISION	BY	NAME	APP'D	DATE
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Raymond Engineers & Constructors
DOWNERS GROVE, ILLINOIS

DESIGN	DATE
CHECKED	DATE
REAC APPROVED	DATE
SUBMIT APPROVED	DATE

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD70
REVISION SCALE: NONE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
LIQUID STORAGE

M-801
FLUIDIZED BED
COMBUSTION REACTOR

M-802
COMBUSTION
AIR FAN

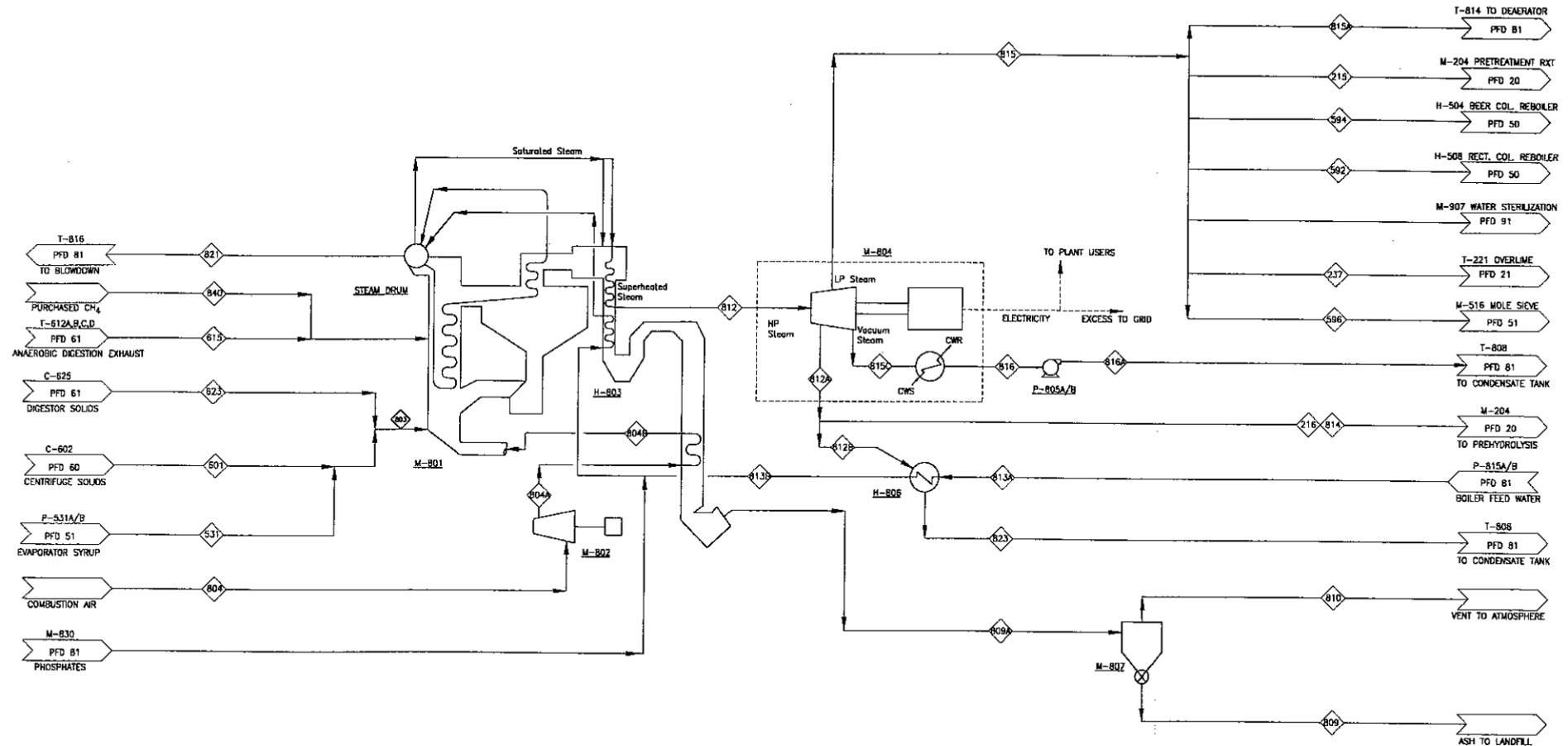
H-803
BURNER COMBUSTION
AIR PREHEATER

M-804
TURBINE/GENERATOR

P-805A/B
TURBINE
CONDENSATE PUMP A/B

H-806
BFW PREHEATER

M-807
COMBUSTION GAS
BAGHOUSE



UTILITY LEGEND

(1) HP STEAM	(10) HOT WATER RETURN
(2) LP STEAM	(11) CIP SUPPLY
(3) HP CONDENSATE	(12) CIP RETURN
(4) LP CONDENSATE	(13) PLANT AIR
(5) CITY WATER (POTABLE)	(14) STERILE AIR
(6) PROCESS WATER	(15) WASTE
(7) COOLING TOWER WATER SUPPLY	(16) WASTE
(8) COOLING TOWER WATER RETURN	(17) NATURAL GAS
(9) HOT WATER SUPPLY	

REV.	DATE	REVISION	BY	REAC.	CLIENT
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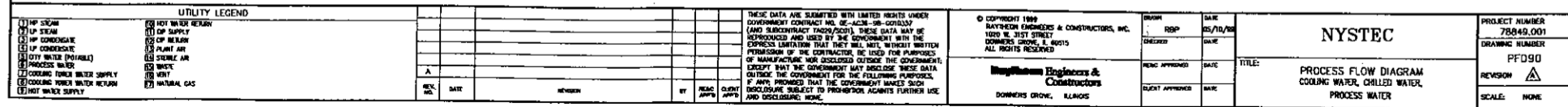
Raymond Engineers & Constructors
DOWNEY, ILLINOIS

DATE	BY	DATE
DESIGNED	05/08/99	
REAC. APPROVED		
CLIENT APPROVED		

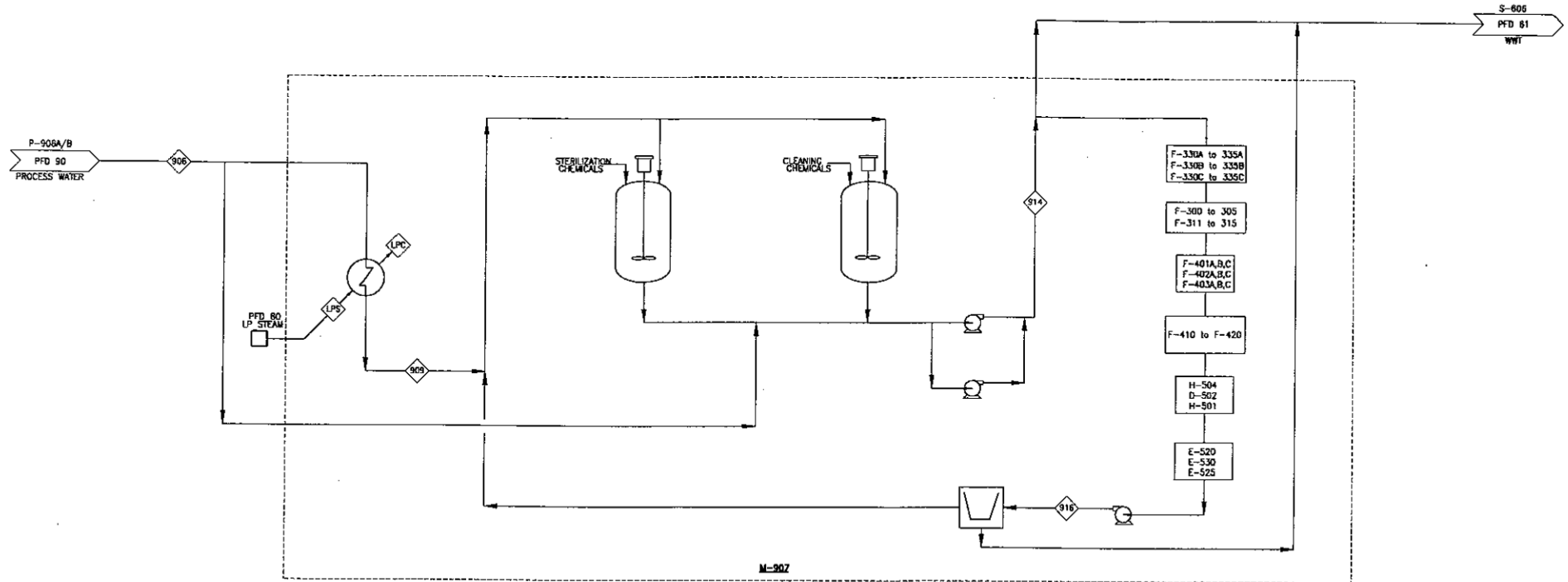
TITLE:

NYSTEC
PROCESS FLOW DIAGRAM
COMBUSTOR AND TURBO GENERATOR

PROJECT NUMBER	78849.001
DRAWING NUMBER	PFD80
REVISION	A
SCALE	NONE



M-907
CIP SYSTEM



UTILITY LEGEND									
(1) HP STEAM	(20) HOT WATER RETURN								
(2) LP STEAM	(21) CIP SUPPLY								
(3) HP CONDENSATE	(22) CIP RETURN								
(4) LP CONDENSATE	(23) PLANT AIR								
(5) CITY WATER (POSSIBLE)	(24) STERILE AIR								
(6) PROCESS WATER	(25) WASTE								
(7) COOLING TOWER WATER SUPPLY	(26) WWT								
(8) COOLING TOWER WATER RETURN	(27) NATURAL GAS								
(9) HOT WATER SUPPLY									

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		CHECKED	DATE	DRAWING NUMBER PFD91
		REVISION APPROVED	DATE	REVISION A
		CLIENT APPROVED	DATE	SCALE: NONE

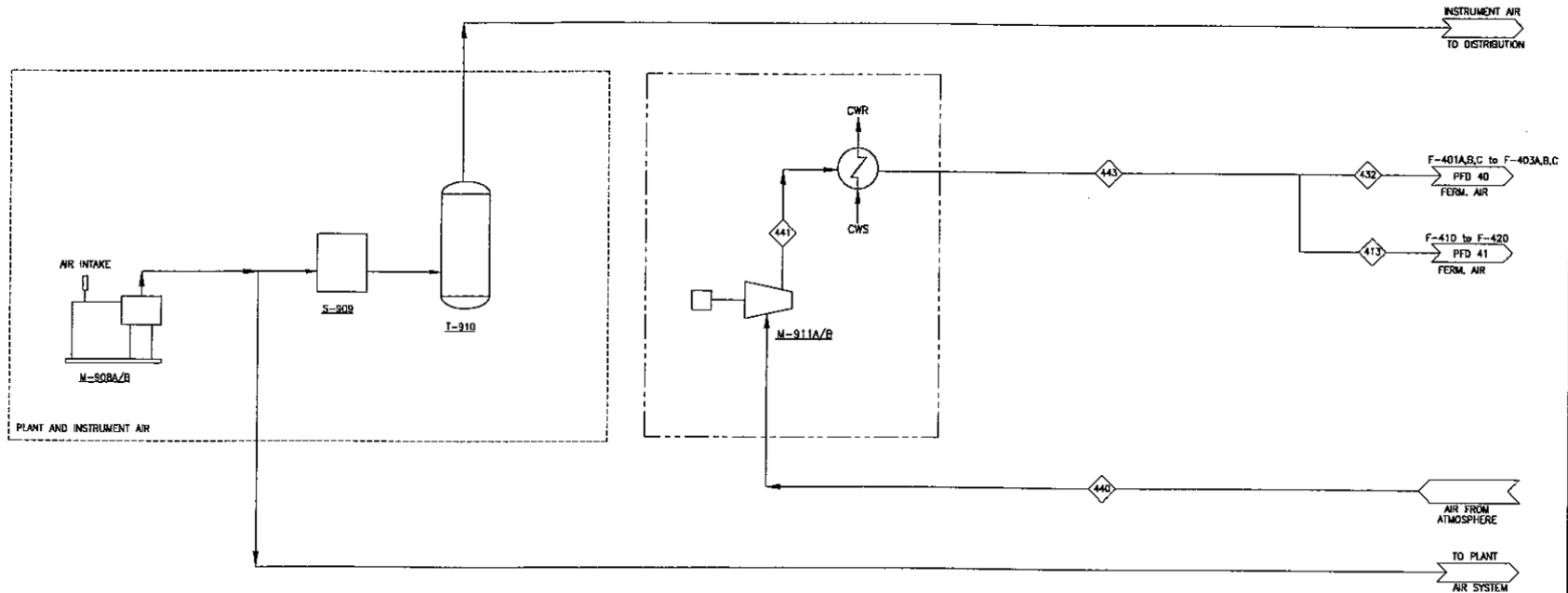
Raytheon Engineers & Constructors DOWNS GROVE, ILLINOIS	TITLE: PROCESS FLOW DIAGRAM CIP SYSTEM
---	--

M-908A/B
PLANT AIR
COMPRESSORS A/B

S-909
INSTRUMENT AIR DRYER

T-910
PLANT AIR RECEIVER

M-911A/B
FERMENTER AIR
COMPRESSOR PACKAGE A/B



UTILITY LEGEND

1) HP STEAM	10) HOT WATER RETURN
2) LP STEAM	11) CP SUPPLY
3) HP CONDENSATE	12) CP RETURN
4) LP CONDENSATE	13) PLANT AIR
5) CITY WATER (POTABLE)	14) STUBBY AIR
6) PROCESS WATER	15) WASTE
7) COOLING TOWER WATER SUPPLY	16) WWT
8) COOLING TOWER WATER RETURN	17) NATURAL GAS
9) HOT WATER SUPPLY	

REV.	DATE	REVISION	BY	REAC.	CHECK.	APPROV.
A						

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Rayburn Engineers & Constructors
DOWNEY, CALIF. 90241

DATE	DATE
05/10/89	
DATE	DATE

NYSTEC

TITLE: **PROCESS FLOW DIAGRAM**
PLANT / INSTRUMENT AIR & FERMENTATION AIR

PROJECT NUMBER
78849.001

DRAWING NUMBER
PFD92

REVISION
A

SCALE: NONE

NREL Draft Final Report

Building a Bridge to the Corn Ethanol Industry



III. CORN TO ETHANOL PLANT REFERENCE

A. PROCESS DESCRIPTION

This reference is a standard 30MM gal/yr corn to ethanol plant, utilizing a typical dry corn grind with wet distiller's grain by-product. Since the wet feed can be utilized for dairy cattle on an immediate basis, drying is not needed and can save capitol investment costs. The plant saccharification is accomplished through a purchased enzyme. The starch cooking is by steam jet cooker. The fermentation is done by purchased enzymes. The recovery of alcohol is a two-column distillation system with molecular sieve dehydration. There is no co-generation of power. No by-product germ or gluten streams are made.

NREL Draft Final Report

Building a Bridge to the Corn Ethanol Industry



B. PROCESS PLANT SUMMARY CONSTRUCTION COST ESTIMATE

This cost estimate was developed from a green field, site-specific Fall, 1998 project. The cost estimate is based on equipment quotes and material take-offs developed through extensive preliminary engineering efforts. The equipment take-offs are presented in the priced equipment list. The estimate includes site development costs.

Raytheon Engineers & Constructors

CLIENT: NYSTEC
PROJECT: 30 MM GAL/YR CORN TO ETHANOL FACILITY
LOCATION: NEW YORK
JOB NO.: 78849.001

MID AMERICA / CHICAGO OFFICE

DATE : 10-Jul-99
PRICED BY : PMF
REV. NO. :

RE&C ACCT	DESCRIPTION	MANHOURS	LABOR	MATERIAL	SUBS	TOTAL	% TOTAL	% TOTAL '06'
01	IMPROVEMENTS TO SITE		\$176,800	\$265,200		\$442,000	0.6%	2.6%
02	EARTHWORK		\$348,100	\$332,900		\$681,000	1.0%	4.0%
03	CONCRETE		\$1,110,200	\$931,800		\$2,042,000	2.9%	12.0%
05	STRUCTURAL STEEL		\$1,968,700	\$1,652,300		\$3,621,000	5.2%	38.0%
06	PROCESS EQUIPMENT		\$1,891,000	\$15,127,000		\$17,018,000	24.2%	100.0%
21	PIPING		\$5,069,000	\$4,461,000		\$9,530,000	13.6%	56.0%
23	INSULATION		\$484,100	\$451,900		\$936,000	1.3%	5.5%
24	INSTRUMENTATION & CONTROLS		\$1,438,200	\$3,837,800		\$5,276,000	7.5%	31.0%
25	ELECTRICAL		\$2,920,500	\$1,844,500		\$4,765,000	6.8%	28.0%
27	PAINTING		\$593,500	\$512,500		\$1,106,000	1.6%	6.5%
40	BUILDINGS & ARCHITECTURAL		\$0		\$4,255,000	\$4,255,000	6.1%	25.0%
DIRECT FIELD COST		0	\$16,000,100	\$29,416,900	\$4,255,000	\$49,672,000	70.8%	308.6%
69	START-UP, TESTING AND TRAINING					Excluded	0.0%	0.0%
70	TEMPORARY FACILITIES					Included Above	0.0%	0.0%
70	CONSTRUCTION EQUIPMENT, TOOLS, SUPPLIES					Included Above	0.0%	0.0%
71	FIELD STAFF AND LEGALITIES					\$2,553,000	3.6%	15.0%
INDIRECT FIELD COST		0	\$0	\$0	\$0	\$2,553,000	3.6%	15.0%
TOTAL FIELD COST		0	\$16,000,100	\$29,416,900	\$4,255,000	\$52,225,000	74.4%	323.6%
72	ENGINEERING (HOME OFFICE)					\$5,617,000	8.0%	33.0%
TOTAL FIELD AND HOME OFFICE						\$57,842,000	82.4%	356.6%
TAXES (Assume Tax Exempt Project)						\$0	0.0%	0.0%
INSURANCE						\$204,000	0.3%	1.2%
PERMITS						\$26,000	0.0%	0.2%
CRAFT CASUAL OVERTIME						\$170,000	0.2%	1.0%
CONTINGENCY						\$10,551,000	15.0%	62.0%
ESCALATION (Excluded)						\$0	0.0%	0.0%
SUBTOTAL						\$68,793,000	98.0%	421.0%
CM FEE						\$1,400,000	2.0%	8.2%
TOTAL (CONSTRUCTION COSTS THROUGH MECHANICAL COMPLETION)						\$70,193,000	100.0%	429.2%

Please note that the cost estimates provided herein are dependent upon the basis of the quantities and pricing utilized to develop them, and upon the underlying assumptions, inclusions, and exclusions. Actual Project costs will differ, and can significantly be affected by changes in the external environment, the manner in which the projects implemented, and other factors which impact the basis upon which the initial estimate was prepared or otherwise affect the project. Estimate accuracy ranges are projections based upon cost estimating methods and practices in accordance with ordinary standards of care normally practiced by recognized engineering firms in performing services of a similar nature. They are not a guarantee of actual project costs.

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NREL Draft Final Report

Building a Bridge to the Corn Ethanol Industry



C. PRICED EQUIPMENT LIST

This is the list corresponding to the Process Plant Summary Construction Cost Estimate.

Project 78849.001
NREL/NYSTEC

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Rev. A, JUNE 1, 1999

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity		Diam.	Height/Head	Misc.	Estimated Cost
					Vol/Flow	Gal/Gpm				
	RECEIVING & GRINDING									
BA-110	BIN ACTIVATOR	010		10						\$19,000
BA-115	BIN ACTIVATOR	010		10						\$19,000
BA-150	BIN ACTIVATOR	010		10						\$19,000
BE-105	CORN UNLOADING BUCKET ELEVATOR	010		75	18,500	CFH				\$60,000
BE-108	CORN SILO LOADING BUCKET ELEVATOR	010		100	18,500	CFH				\$75,000
BE-121	CORN SILO DISCHARGE BUCKET ELEVATOR	010		20	4800	CFH				\$35,000
BE-148	GROUND CORN BUCKET ELEVATOR	010		100						\$75,000
BL-111	SILO FILTER FAN	010		2	900	CFM				w / DC-111
BL-112	SILO VENT FAN	010		1						\$3,500
BL-116	SILO FILTER FAN	010		2	900	CFM				w / DC-116
BL-117	SILO VENT FAN	010		1						\$3,500
BL-125	DUST COLLECTOR BLOWER	010		200	37,000	CFM				w / DC-125
BL-127	DUST COLLECTOR BLOWER	010		200	37,000	CFM				w / DC-127
BL-151	SILO FILTER FAN	010		1						\$3,500
CL-106	CLEANING VIBRATOR SCREEN	010		30	18,500	CFH				\$146,000
CL-107	DESTONER	010		20	50	TONS/HR				\$43,000
CV-103	TRUCK UNLOADING CONVEYOR	010		25	18,500	CFH				\$36,000
CV-109	CORN SILO LOADING CONVEYOR	010		25	18,500	CFH				\$42,000
CV-120	CORN SILO DISCHARGE CONVEYOR	010		15	4800	CFH				\$43,000
CV-122	CORN TRANSFER CONVEYOR	010		15	4800	CFH				\$46,000
CV-140	RAW CORN SUPPLY CONVEYOR	010		15						\$30,000
CV-141	CORN MILLING SUPPLY CONVEYOR	010		15						\$60,000
CV-142	SIFTER	010		15						\$100,000
CV-143	SIFTER	010		15						\$100,000
CV-144	GROUND CORN DRAG CONVEYOR	010		15						\$150,000
CV-147	GROUND CORN SCREW CONVEYOR	010		30	10 - 50	TONS/HR			VARIABLE SPEED	\$25,000
CV-152	GROUND CORN SUPPLY CONVEYOR	010		30						\$25,000
DC-111	SILO FILTER	010		NA						\$7,000
DC-116	SILO FILTER	010		NA						\$7,000
DC-125	DUST COLLECTOR	010		NA						\$80,000
DC-127	DUST COLLECTOR	010		NA						\$23,000
DC-151	DUST COLLECTOR	010		NA						\$7,000
M-145	HAMMERMILL	010		125	10	TONS/HR				\$135,000
M-146	HAMMERMILL	010		125	10	TONS/HR				\$135,000
MM-145	MILL MAGNET	010		1	10	TONS/HR				\$10,000
MM-146	MILL MAGNET	010		1	10	TONS/HR				\$10,000
MS-104	UNLOADING MAGNET	010		NA						\$10,000
RV-126	ROTARY DISCHARGE VALVE	010		0.75						w / DC-125
RV-128	ROTARY DISCHARGE VALVE	010		0.75						w / DC-127
SL-101	CORN TRUCK SCALE	010		NA						
TK-102	TRUCK UNLOADING HOPPER	010		NA						\$18,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity		Diam.	Height/Head	Misc.	Estimated Cost
					Vol/Flow	Gal/Gpm				
TK-110	CORN STORAGE SILO	010		NA	100,000	CF	40'-0"	110'-0"		\$292,000
TK-115	CORN STORAGE SILO	010		NA	100,000	CF	40'-0"	110'-0"		\$292,000
TK-150	GROUND CORN STORAGE	010		NA	1500	CF				\$42,000
	HYDROLYSIS								Subtotal	\$2,226,500
AG-201	SLURRY TANK AGITATOR	020	304 SS	40					TURBINE	\$20,000
AG-205A	1ST HOLD TANK AGITATOR A	020	304 SS	5					TURBINE	\$10,000
AG-205B	1ST HOLD TANK AGITATOR B	020	304 SS	5					TURBINE	\$10,000
AG-205C	1ST HOLD TANK AGITATOR C	020	304 SS	5					TURBINE	\$10,000
AG-215A	2ND HOLD TANK AGITATOR A	020	304 SS	5						\$10,000
AG-215B	2ND HOLD TANK AGITATOR B	020	304 SS	5						\$10,000
AG-215C	2ND HOLD TANK AGITATOR C	020	304 SS	5						\$10,000
AG-215D	2ND HOLD TANK AGITATOR D	020	304 SS	5						\$10,000
AG-215E	2ND HOLD TANK AGITATOR E	020	304 SS	5						\$10,000
AG-230	MIX TANK AGITATOR	020	304 SS	2					TOP ENTERING	\$5,000
AG-240	SACCHARIFICATION TANK AGITATOR	020	304 SS	15					SIDE ENTERING	\$12,000
AG-241	SACCHARIFICATION TANK AGITATOR	020	304 SS	15					SIDE ENTERING	\$12,000
AG-250	YEAST PROPAGATION TANK AGITATOR	020	304 SS	3					VARIABLE SPEED, SINGLE MECH. SEAL	\$13,000
AG-265	ANTIFOAM TANK AGITATOR	020	316 SS	1					SINGLE MECHANICAL SEAL	\$7,000
E-207	HOLDING COIL	020	304 SS	NA						\$20,000
EX-212	VAPOR CONDENSER	020	4 SS TUBE	NA					SHELL & TUBE	\$20,000
EX-222	VAPOR CONDENSER	020	4 SS TUBE	NA					SHELL & TUBE	\$20,000
EX-242	MASH COOLER	020		NA					PLATE & FRAME	\$90,000
EX-243	MASH COOLER	020		NA					PLATE & FRAME	\$90,000
F-251	AIR PRE-FILTER	020	316 SS	NA	50	LB/HR			CARTRIDGE, 8 MICRONS	\$2,000
F-252	AIR STERILE FILTER	020	316 SS	NA	50	LB/HR			CARTRIDGE, 0.2 MICRONS ABSOLUTE	\$2,000
F-253	STEAM FILTER	020	316 SS	NA	600	LB/HR			CARTRIDGE, 1.5 MICRONS ABSOLUTE	\$4,000
JC-206	JET COOKER	020	316 SS	NA						\$26,000
PU-205A	1ST HOLD PUMP A	020	CD4M	200	800	GPM		100 FT. TDH	CENTRIFUGAL	\$6,000
PU-205B	1ST HOLD PUMP B	020	CD4M	200	800	GPM		100 FT. TDH	CENTRIFUGAL	\$6,000
PU-215A	2ND HOLD PUMP A	020	CD4M	30	800	GPM		100 FT. TDH	CENTRIFUGAL	\$6,000
PU-215B	2ND HOLD PUMP B	020	CD4M	30	800	GPM		100 FT. TDH	CENTRIFUGAL	\$6,000
PU-221A	MASH PUMP A	020	CD4M	25	800	GPM		100 FT. TDH	CENTRIFUGAL	\$6,000
PU-221B	MASH PUMP B	020	CD4M	25	800	GPM		100 FT. TDH	CENTRIFUGAL	\$6,000
PU-230A	MIX TANK PUMP A	020	CD4M	50		GPM		100 FT. TDH	PD	\$5,000
PU-230B	MIX TANK PUMP B	020	CD4M	50		GPM		100 FT. TDH	PD	\$5,000
PU-240A	SACCHARIFICATION TANK PUMP A	020	CD4M	75	1300	GPM		100 FT. TDH	CENTRIFUGAL	\$10,000
PU-240B	SACCHARIFICATION TANK PUMP B	020	CD4M	75	1300	GPM		100 FT. TDH	CENTRIFUGAL	\$10,000
PU-250	YEAST PROPAGATION TANK PUMP	020	316 SS	7.5	150	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$5,000
PU-255	AG ENZYME METERING PUMP	020	316 SS	0.5	25	GPM			METERING	\$5,000
PU-260	ALPHA AMYLASE METERING PUMP	020	316 SS	0.5	15	GPM			METERING	\$5,000
PU-265	ANTIFOAM AGENT PUMP	020	316 SS	15	15	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$3,000
PU-266	ANTIFOAM DRUM PUMP	020	316 SS	NA					AIR OPERATED DOUBLE DIAPHRAGM	\$3,000

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity		Diam.	Height/Head	Misc.	Estimated Cost
					Vol/Flow	Gal/Gpm				
TK-201	SLURRY TANK	020	304 SS	NA	20,000	GAL	13'-0"	22'-0"	CONE TOP, FLAT BOTTOM	\$50,000
TK-205	1ST HOLDING TANK	020	304 SS	NA	25,000	GAL	13'-0"	26'-0"	HORIZONTAL, 4 COMPARTMENTS	\$65,000
TK-210	FLASH COOLER A	020	304 SS	NA	3,500	GAL	8'-0"	10'-0"	DISHED TOP, CONE BOTTOM	\$15,000
TK-211	FLASH COOLER B	020	304 SS	NA	13,000	GAL	12'-0"	16'-0"	DISHED HEADS	\$15,000
TK-215	2ND HOLDING TANK	020	304 SS	NA	52,800	GAL	15'-0"	40'-0"	HORIZONTAL	\$75,000
TK-220	FLASH COOLER	020	304 SS	NA	5,700	GAL	9'-0"	12'-0"	DISHED TOP, CONE BOTTOM	\$15,000
TK-230	MIX TANK	020	CS (LINED)	NA	6,000	GAL	8'-0"	16'-0"	VERTICAL, DISHED HEADS	\$50,000
TK-240	SACCHARIFICATION TANK	020	CS (LINED)	NA	87,000	GAL	20'-0"	37'-0"	DISHED TOP, SLOPED BOTTOM	\$115,000
TK-241	SACCHARIFICATION TANK	020	CS (LINED)	NA	87,000	GAL	20'-0"	37'-0"	DISHED TOP, SLOPED BOTTOM	\$115,000
TK-250	YEAST PROPAGATION TANK	020	304L SS	NA	12,350	GAL	10'-0"	20'-0"	VERTICAL, DISHED HEADS, 45 PSIG/FV, JKT	\$87,000
TK-255	AG ENZYME TANK	020	FRP	NA	7,000	GAL	8'-0"	20'-0"	VERTICAL, DISHED HEADS	\$20,000
TK-260	ALPHA AMYLASE TANK	020	FRP	NA	6,000	GAL	8'-0"	16'-0"	VERTICAL CYLINDRICAL	\$20,000
TK-265	ANTIFOAM TANK	020	304L SS	NA	1600	GAL	6'-0"	8'-0"	DISHED HEADS, +12" / -12" W.C.	\$20,000
VP-225	VACUUM PUMP PACKAGE	020		30	900	ACFM			LIQUID RING, 24.3" Hg VACUUM	\$40,000
Subtotal										\$1,212,000
FERMENTATION										
AG-301	SEED FERMENTER A AGITATOR	030	316 SS	15					DOUBLE MECH. SEAL	\$8,000
AG-305	PRE-FERMENTER A AGITATOR	030	316 SS	25					DOUBLE MECH. SEAL	\$11,000
AG-310	SEED FERMENTER B AGITATOR	030	316 SS	15					DOUBLE MECH. SEAL	\$8,000
AG-315	PRE-FERMENTER B AGITATOR	030	316 SS	25					DOUBLE MECH. SEAL	\$11,000
AG-320	FERMENTER #1 AGITATOR	030	316 SS	50					DOUBLE MECH. SEAL	\$12,000
AG-325	FERMENTER #2 AGITATOR	030	316 SS	50					DOUBLE MECH. SEAL	\$12,000
AG-330	FERMENTER #3 AGITATOR	030	316 SS	50					DOUBLE MECH. SEAL	\$12,000
AG-335	BEER WELL AGITATOR	030	304 SS	10						\$12,000
C-341	CO2 COMPRESSOR	030	CAST IRON	150	3250	ICFM			VARIABLE SPEED	\$115,000
EX-302	SEED FERMENTER A COOLER	030		NA					PLATE & FRAME	\$14,000
EX-306	PRE-FERMENTER A COOLER	030		NA					PLATE & FRAME	\$18,000
EX-311	SEED FERMENTER B COOLER	030		NA					PLATE & FRAME	\$14,000
EX-316	PRE-FERMENTER B COOLER	030		NA					PLATE & FRAME	\$18,000
EX-321	FERMENTER #1 COOLER	030		NA					PLATE & FRAME	\$18,000
EX-326	FERMENTER #2 COOLER	030		NA					PLATE & FRAME	\$18,000
EX-331	FERMENTER #3 COOLER	030		NA					PLATE & FRAME	\$18,000
PU-301	SEED FERMENTER A PUMP	030	316 SS	40	600	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	\$9,000
PU-305	PRE-FERMENTER A PUMP	030	316 SS	75	1400	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	\$13,000
PU-310	SEED FERMENTER B PUMP	030	316 SS	40	600	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	\$9,000
PU-315	PRE-FERMENTER B PUMP	030	316 SS	75	1400	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	\$13,000
PU-320	FERMENTER #1 PUMP	030	316 SS	125	2250	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	\$12,000
PU-325	FERMENTER #2 PUMP	030	316 SS	125	2250	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	\$12,000
PU-330	FERMENTER #3 PUMP	030	316 SS	125	2250	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	\$12,000
PU-335	BEER WELL PUMP	030	304 SS	35					CENTRIFUGAL	\$12,000
TK-301	SEED FERMENTER (TRAIN A)	030	304L SS	NA	95,000	GAL	22'-0"	40'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12" VAC.	\$150,000
TK-305	PRE-FERMENTER (TRAIN A)	030	304L SS	NA	190,000	GAL	30'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12" VAC.	\$210,000
TK-310	SEED FERMENTER (TRAIN B)	030	304L SS	NA	95,000	GAL	22'-0"	40'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12" VAC.	\$150,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity		Diam.	Height/Head	Misc.	Estimated Cost
					Vol/Flow	Gal/Gpm				
TK-315	PRE-FERMENTER (TRAIN B)	030	304L SS	NA	190,000	GAL	30'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	\$210,000
TK-320	FERMENTER #1	030	304L SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	\$250,000
TK-325	FERMENTER #2	030	304L SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	\$250,000
TK-330	FERMENTER #3	030	304L SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	\$250,000
TK-335	BEER WELL	030	304 SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM	\$250,000
V-340	CO2 SCRUBBER	030	304 SS	NA					5 PSIG / 20" W.C. VAC.	\$30,000
DISTILLATION & RECTIFICATION										
									Subtotal	\$2,161,000
C-417	MASH COLUMN VACUUM PUMP	040		30	700	CFM				\$40,000
C-420	DEHYDRATION VACUUM PUMP	040		10	250	CFM				\$40,000
EX-402	MASH COLUMN REBOILER	040		NA					SHELL & TUBE	\$165,000
EX-403	MASH PREHEATER #1	040		NA					SHELL & TUBE	\$95,000
EX-404	MASH COLUMN AFTER CONDENSER	040		NA					PLATE & FRAME	\$137,000
EX-411	RECTIFICATION COLUMN REBOILER	040		NA					SHELL & TUBE	\$20,000
EX-412	RECTIFICATION FEED HEATER	040		NA					PLATE & FRAME	\$10,000
EX-413	FUSEL COOLER	040		NA					PLATE & FRAME	\$5,000
EX-416	VACUUM PUMP COOLER #1	040		NA					SHELL & TUBE	\$20,000
EX-419	VACUUM PUMP COOLER #2	040		NA					SHELL & TUBE	\$20,000
EX-432	VAPOR HEATER	040		NA					SHELL & TUBE	\$10,000
EX-433	REGEN. MAIN CONDENSER	040		NA					PLATE & FRAME	\$43,000
EX-441	PRODUCT COOLER	040		NA					PLATE & FRAME	\$20,000
EX-442	CONDENSER	040		NA					PLATE & FRAME	\$20,000
PU-401A	MASH COLUMN RECYCLE PUMP	040	316 SS	100	7000	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$29,000
PU-401B	STILLAGE PUMP	040	316 SS	30	700	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$10,000
PU-405	RECTIFICATION REFLUX TANK PUMP	040	316 SS	25	400	GPM		100 FT. TDH	CENTRIFUGAL	\$6,000
PU-406	RECTIFICATION FEED TANK PUMP	040	316 SS	7.5	150	GPM		100 FT. TDH	CENTRIFUGAL	\$4,000
PU-410	STILLAGE WATER PUMP	040	316 SS	7.5	300	GPM		100 FT. TDH	CENTRIFUGAL	\$7,000
PU-425	WATER REFLUX TANK PUMP	040	316 SS	5	50	GPM		100 FT. TDH	CENTRIFUGAL	\$4,000
PU-434	REGEN. REFLUX TANK PUMP	040	316 SS	3	25	GPM		100 FT. TDH	CENTRIFUGAL	\$3,000
PU-440	PRODUCT TANK PUMP	040	316 SS	7.5	100	GPM		100 FT. TDH	CENTRIFUGAL	\$4,000
TK-405	RECTIFICATION REFLUX TANK	040	304L SS	NA	2250	GAL	6'-0"	12'-0"	50 PSIG / FV	\$23,000
TK-406	RECTIFICATION FEED TANK	040	304L SS	NA	1250	GAL	5'-0"	10'-0"	45 PSIG / FV	\$20,000
TK-407	VAPOR-LIQUID SEPARATOR	040		NA						\$15,000
TK-425	WATER REFLUX TANK	040		NA	300	GAL	3'-0"	6'-0"	ATMOSPHERIC	\$13,000
TK-434	REGEN. REFLUX TANK	040		NA	200	GAL	2'-6"	5'-0"	45 PSIG / FV	\$13,000
TK-440	PRODUCT TANK	040		NA	1250	GAL	5'-0"	10'-0"		\$21,000
V-401	MASH COLUMN	040		NA					VERTICAL, 50 PSIG	\$204,000
V-410A	RECTIFICATION COLUMN LOWER SECTION	040		NA						w / V-410B
V-410B	RECTIFICATION COLUMN UPPER SECTION	040		NA						\$160,000
V-415	CO2 STRIPPER	040		NA	185	GAL				\$22,000
V-418	WATER SEPARATION VESSEL	040		NA	35	GAL	1'-6"	3'-0"		w / C-417
V-426	FUSEL DECANTER	040		NA	125	GAL	2'-0"	5'-0"		\$9,000
V-430	MOLECULAR SIEVE	040		NA					45 PSIG / FV	\$400,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity Vol/Flow	Gal/Gpm	Diam.	Height/Head	Misc.	Estimated Cost
V-431	MOLECULAR SIEVE	040		NA					45 PSIG / FV	\$400,000
X-401	MASH COLUMN INTERNALS	040		NA						\$50,000
X-410	RECTIFICATION COLUMN UPPER / LOWER INTERNALS	040		NA						\$200,000
X-415	CO2 STRIPPER INTERNALS	040		NA						\$15,000
	THIN STILLAGE & WDGS								Subtotal	\$2,277,000
AG-510	THIN STILLAGE TANK AGITATOR	050	316 SS	10					DOUBLE MECH. SEAL	\$8,000
AG-515	CONCENTRATE TANK AGITATOR	050	316 SS	5					SINGLE MECH. SEAL	\$18,000
PU-505	DECANTER OVERFLOW TANK PUMP	050	316 SS	30	700	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$5,000
PU-510A	EVAPORATOR FEED PUMP	050	316 SS	50	350	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$6,000
PU-510B	THIN STILLAGE RECYCLE PUMP	050	316 SS	40	450	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$6,000
PU-515	CONCENTRATE TANK PUMP	050	316 SS	5		GPM		100 FT. TDH	DOUBLE MECH. SEAL	\$8,000
SE-501	DECANTER #1	050		320					270 HP & 50 HP MOTORS	\$600,000
SE-502	DECANTER #2	050		320					270 HP & 50 HP MOTORS	\$600,000
SE-503	DECANTER #3	050		320					270 HP & 50 HP MOTORS	\$600,000
TK-505	DECANTER OVERFLOW TANK	050	304L SS	NA	8000	GAL	9'-0"	16'-0"	DISHED HEADS, +12" / -12" W.C.	\$26,000
TK-510	THIN STILLAGE TANK	050	304L SS	NA	32,000	GAL	14'-0"	28'-0"	CONE TOP, SLOPED BOTT., 0.29 PSIG/-12"W.C.	\$52,000
TK-515	CONCENTRATE TANK	050	304L SS	NA	32,000	GAL	14'-0"	28'-0"	CONE TOP, SLOPED BOTT., 0.29 PSIG/-12"W.C.	\$54,000
	EVAPORATION								Subtotal	\$1,983,000
C-620	MVR COMPRESSOR	060		1000						w / E-601
E-601	EVAPORATOR CHEST A	060		NA						\$1,750,000
E-610	EVAPORATOR CHEST B	060	304L / 316L	NA					SHELL & TUBE	w / E-601
HE-630	EVAP. FEED PRE-HEATER	060	304L / 316L	NA					SHELL & TUBE	w / E-601
PU-601A	EVAPORATOR A FIRST PASS RECYCLE PUMP	060		125	3300	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-601B	EVAPORATOR A SECOND PASS RECYCLE PUMP	060		75	1600	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-610A	EVAPORATOR B FIRST PASS RECYCLE PUMP	060		125	3300	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-610B	EVAPORATOR B SECOND PASS RECYCLE PUMP	060		75	1600	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-625	EVAP. CONDENSATE PUMP	060		25						w / E-601
TK-605	EVAPORATOR VAPOR SEPARATOR A	060	304L SS	NA	30,000	GAL	14'-0"	25'-0"	DISHED HEADS, 15 PSIG / FV	w / E-601
TK-615	EVAPORATOR VAPOR SEPARATOR B	060	304L SS	NA	30,000	GAL	14'-0"	25'-0"	DISHED HEADS, 15 PSIG / FV	w / E-601
TK-625	EVAP. CONDENSATE TANK	060		NA						w / E-601
	PRODUCT LOADOUT								Subtotal	\$1,750,000
BL-730	DUST COLLECTOR EXHAUST BLOWER	070		125						\$40,000
CV-735	DDGS STORAGE CONVEYOR	070	CS	20	2000	CFH				\$125,000
CV-736	DDGS RECLAIM CONVEYOR	070		75	12,000	CFH				\$120,000
DC-725	DUST COLLECTOR	070		NA						\$28,000
EX-704	ETHANOL VAPOR RECOVERY PACKAGE	070								\$50,000
F-731	DUST COLLECTOR SAFETY AIR FILTER	070		NA						W / BL-730
LA-712	ETHANOL / GASOLINE PRODUCT LOADING ARM	070		NA						\$10,000
MH-739	DDGS ROTARY TYPE POSITIONER	070		0.75	12,000	CFH				W / MH-740
MH-740	DDGS RETRACTABLE LOADING SPOUT	070		0.75	12,000	CFH				\$16,500
MI-720	PADDLE MIXER	070		60						\$61,000
MX-703	ETHANOL / GASOLINE IN-LINE MIXER	070		NA					STATIC	\$3,500

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity		Diam.	Height/Head	Misc.	Estimated Cost
					Vol/Flow	Gal/Gpm				
PU-701A	ETHANOL CHECK TANK PUMP A	070	316 SS	15	250	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$2,500
PU-701B	ETHANOL CHECK TANK PUMP B	070	316 SS	15	250	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$2,500
PU-703	OFF-SPEC ETHANOL FEED PUMP	070	316 SS	20					CENTRIFUGAL	\$2,500
PU-710A	GASOLINE STORAGE TANK PUMP A	070	316 SS	3	5	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$2,000
PU-710B	GASOLINE STORAGE TANK PUMP B	070	316 SS	3	5	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$2,000
PU-711	ETHANOL PRODUCT TANK PUMP	070	316 SS	50	750	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$5,500
RV-725	DUST COLLECTOR ROTARY AIRLOCK	070		1.5						\$8,500
SL-730A	BLOWER SILENCER A	070		NA						W / BL-730
SL-730B	BLOWER SILENCER B	070		NA						W / BL-730
SL-741	DDGS TRUCK SCALE	070		NA						
TK-701	ETHANOL CHECK TANK A	070	CS	NA	17,000	GAL	13'-0"	17'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -1.5" W.C.	\$21,000
TK-702	ETHANOL CHECK TANK B	070	CS	NA	17,000	GAL	13'-0"	17'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -1.5" W.C.	\$21,000
TK-703	OFF-SPEC ETHANOL TANK	070	CS	NA					CONE TOP, FLAT BOTTOM	\$21,000
TK-710	GASOLINE STORAGE TANK	070	CS	NA	60,000	GAL	18'-0"	35'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -1.5" W.C.	\$95,000
TK-711	ETHANOL PRODUCT TANK	070	CS	NA	600,000	GAL	44'-0"	55'-0"	FLAT TOP, CONE BOTTOM, +2.5" / -1.5" W.C.	\$240,000
	WASTE WATER TREATMENT								Subtotal	\$877,500
AG-815A	NEUTRALIZATION TANK AGITATOR #1	080		5						\$12,000
AG-815B	NEUTRALIZATION TANK AGITATOR #2	080		5						\$12,000
EX-821	CIP HEATER	080		NA					SHELL & TUBE	\$10,000
PU-801	H2O2 PUMP	080	316 SS	NA	35	LB/HR			AIR OPERATED DOUBLE DIAPHRAGM	\$4,000
PU-802	H3PO4 PUMP	080	316 SS	NA	20	LB/HR			AIR OPERATED DOUBLE DIAPHRAGM	\$4,000
PU-805	NaOH STORAGE TANK PUMP	080	316 SS	7.5	10	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	\$2,000
PU-810	H2SO4 STORAGE TANK PUMP	080	316 SS	7.5	25	GPM		100 FT. TDH		\$2,000
PU-816	SULFURIC ACID METERING PUMP	080		0.5					METERING	\$7,000
PU-820	CIP PUMP	080	316 SS	150		GPM			CENTRIFUGAL, DOUBLE MECH. SEAL	\$12,000
TK-805	50% CAUSTIC STORAGE TANK	080	CS	NA	9000	GAL	10'-0"	16'-0"	VERTICAL, DISHED HEADS	\$16,000
TK-810	H2SO4 STORAGE TANK	080	CS	NA	9000	GAL	10'-0"	16'-0"	HORIZONTAL, +1 PSIG / -12" W.C.	\$22,000
TK-815	NEUTRALIZATION TANK	080	304L SS	NA	15,000	GAL	13'-0"x13'-0"	12'-0"	2 COMPARTMENTS, +12" / -12" W.C.	\$57,000
TK-820	CIP TANK	080	304L SS	NA	35,000	GAL	17'-0"x17'-0"	17'-0"	RECTANGULAR, 3 COMPARTMENTS	\$61,000
TK-830	AERATED WASTEWATER TREATMENT SYSTEM	080								\$150,000
	UTILITIES								Subtotal	\$371,000
B-901	UTILITY BOILER	090		200	72,500	LB/HR			150 PSIG	\$450,000
B-902	UTILITY BOILER	090		200	72,500	LB/HR			150 PSIG	\$450,000
C-950A	AIR COMPRESSOR A	090		300	1000	SCFM			130 PSIG DISCH. PRESSURE	\$87,000
C-950B	AIR COMPRESSOR B	090		300	1000	SCFM			130 PSIG DISCH. PRESSURE	\$87,000
CT-930	COOLING TOWER THREE (3) CELL	090		300	12,000	GPM			(2) 150 HP REVERSIBLE FANS	\$400,000
DA-903	BOILER DEAERATOR	090	CS	NA	150,000	LB/HR			50 PSIG	\$29,000
DR-952	AIR DRYER PACKAGE	090		NA	1000	SCFM			DEWPOINT -60 F	\$15,000
EX-916	MAKE-UP WATER PREHEATER	090		NA					SHELL & TUBE	\$13,500
J-905	DESUPERHEATER	090		NA						\$10,000
PU-903A	BOILER FEED WATER PUMP A	090		150	350	GPM		100 FT. TDH	CENTRIFUGAL	\$50,000
PU-903B	BOILER FEED WATER PUMP B	090		150	350	GPM		100 FT. TDH	CENTRIFUGAL	\$50,000

Project 78849.001
NREL/NYSTEC

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Rev. A,JUNE 1,1999

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity		Diam.	Height/Head	Misc.	Estimated Cost
					Vol/Flow	Gal/Gpm				
PU-915A	SOFTENED WATER PUMP A	090	316 SS	10	60	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	\$2,000
PU-915B	SOFTENED WATER PUMP B	090	316 SS	10	60	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	\$2,000
PU-921A	DESUPERHEATER CONDENSATE PUMP	090	316 SS	7.5	20	GPM		100 FT. TDH	CENTRIFUGAL	\$4,000
PU-921B	LP CONDENSATE FLASH TANK PUMP A	090	316 SS	25	360	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	\$5,000
PU-921C	LP CONDENSATE FLASH TANK PUMP B	090	316 SS	25	360	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	\$5,000
PU-930A	COOLING WATER PUMP A	090		300	6,000	GPM		100 FT. TDH	VERTICAL TURBINE	\$21,000
PU-930B	COOLING WATER PUMP B	090		300	6,000	GPM		100 FT. TDH	VERTICAL TURBINE	\$21,000
PU-930C	COOLING WATER PUMP C	090		300	6,000	GPM		100 FT. TDH	VERTICAL TURBINE	\$21,000
PU-931A	SULFURIC ACID INJECTION PUMP A	090		0.25	5	GPH		100 FT. TDH	METERING	\$4,000
PU-931B	SULFURIC ACID INJECTION PUMP B	090		0.25	5	GPH		100 FT. TDH	METERING	\$4,000
PU-960A	SEAL WATER RECIRCULATING PUMP	090	316 SS	15	50	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	\$2,500
PU-960B	STANDBY RECIRCULATING PUMP	090	316 SS	15	50	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	\$2,500
TK-915	SOFTENED WATER TANK	090	FRP	NA	22,500	GAL	12'-0"	26'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -2.5" W.C.	\$33,000
TK-920	CONVERTER CONDENSATE FLASH TANK	090	CS	NA	1250	GAL	5'-0"	8'-0"	VERTICAL, DISHED HEADS, 25 PSIG / FV	\$9,000
TK-921	LP CONDENSATE FLASH TANK	090	CS	NA	10,500	GAL	11'-0"	14'-0"	VERTICAL, DISHED HEADS, 14.9 PSIG / FV	\$24,000
TK-960	SEAL WATER TANK	090	304L SS	NA	600	GAL	4'-0"	6'-0"	VERTICAL, DISHED HEADS, +12" / -12" W.C.	\$13,500
V-904	BLOWDOWN TANK	090		NA	1200	GAL	4'-0"	12'-0"	VERTICAL, DISHED HEADS, +12" / -12" W.C.	\$9,000
V-951	AIR RECEIVER	090		NA	1150	CF	7'-0"	30'-0"	VERTICAL, DISHED HEADS	\$40,000
WF-910	WATER SOFTENER PACKAGE	090		NA						\$40,000
			Est. Total Hp	9,133	6,804	KW			Subtotal	\$1,904,000
	CHUTES & DUCT ALLOWANCES									\$200,000
									TOTAL	\$14,762,000

NREL Draft Final Report

Building a Bridge to the Corn Ethanol Industry



D. PLANT OPERATING COST ESTIMATE

This estimate fits the plant. Please notice the price of the enzymes. These are not translatable to the biomass alcohol plant.

ESTIMATED OPERATING COSTS AND REVENUES

ANNUAL OPERATING COSTS WITH ENZYME FERMENTATION

Corn	12,000,000 Bu/year	\$2.80 Bu	\$33,600,000
Labor			\$5,147,550
Operating Supplies			\$350,000
Maintenance Materials			\$983,100
Lubricants			\$6,000
Laboratory Chemicals			\$48,000
Operating Chemicals			
H2SO4	154 pounds/hr	\$0.03	\$33,634
NH3	51 pounds/hr	\$0.11	\$44,982
Antifoam	8 pounds/hr	\$10.00	\$672,000
Gasoline	178 gal/hr	\$0.60	\$897,120
Water	49 cu.ft./hr	\$0.67	\$273,521
Natural Gas	24 MMBTU/hr	\$1.86	\$374,976
BFW Chemicals	2 pounds/hr	\$0.97	\$17,926
CW Chemicals	11 pounds/hr	\$1.00	\$92,400
Ammonium Phosphate	5 pounds/hr	\$0.66	\$27,720
Urea	5 pounds/hr	\$0.21	\$8,820
NAOH	80 pounds/hr	\$0.17	\$110,880
H3PO4	11 pounds/hr	\$0.37	\$34,188
H2O2	22 pounds/hr	\$0.50	\$91,476
Novo Ban 240L	22 pounds/hr	\$5.00	\$924,000
Novo Ban AMG 300L	60 pounds/hr	\$5.40	\$2,721,600
Novozym 188	24 pounds/hr	\$21.00	\$4,233,600
Econase CE15	50 pounds/hr	\$3.80	\$1,596,000
Electricity	7,800 kw/hr	\$0.040 /kwh	\$2,620,800
TOTAL COSTS			\$54,910,292

ANNUAL OPERATING REVENUES

Alcohol	30,000,000 gal/yr	\$1.65 per gal	\$49,500,000
WDGS@60% moisture	216,000 tons/yr	\$85.00 /ton	\$18,360,000
TOTAL REVENUES			\$67,860,000

CASH FLOW \$12,949,708

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Building a Bridge to the Corn Ethanol Industry



E. PLANT LABOR ESTIMATE

There are some of the same basic jobs and costs here as associated with the biomass plant. The difference is in the receiving of the feedstock and the shipping of the by-product for the corn plant.

ESTIMATED PLANT LABOR COST FOR CORN TO ETHANOL FACILITY

Staffing	No. of People	Rate (W2)	Salary	Cost w/benefits 1.23
Plant Manager	1	\$ 62.50	\$125,000	\$153,750
Secretary	1	\$ 20.00	\$40,000	\$49,200
Human Resources Manager	1	\$ 40.00	\$80,000	\$98,400
Clerk	1	\$ 25.00	\$50,000	\$61,500
Accounting Manager	1	\$ 45.00	\$90,000	\$110,700
Clerk	1	\$ 15.00	\$30,000	\$36,900
Check Writer	1	\$ 20.00	\$40,000	\$49,200
Senior Plant Engineer	1	\$ 40.00	\$80,000	\$98,400
Plant Engineer	1	\$ 35.00	\$70,000	\$86,100
QC Manager	1	\$ 45.00	\$90,000	\$110,700
Senior Chemist	1	\$ 35.00	\$70,000	\$86,100
Chemists	4	\$ 25.00	\$200,000	\$246,000
Utility	4	\$ 15.00	\$120,000	\$147,600
Procurement Manager	1	\$ 35.00	\$70,000	\$86,100
Logistics Manager	1	\$ 55.00	\$110,000	\$135,300
Supervisors	2	\$ 35.00	\$140,000	\$172,200
Clerks	1	\$ 15.00	\$30,000	\$36,900
Shipping & Receiving Manager	1	\$ 35.00	\$70,000	\$86,100
Guards	8	\$ 20.00	\$320,000	\$393,600
Shipping & Receiving Utility	2	\$ 20.00	\$80,000	\$98,400
Operations Manager	1	\$ 55.00	\$110,000	\$135,300
Shift Supervisors	4	\$ 30.00	\$240,000	\$295,200
Control Room Operators	8	\$ 25.00	\$400,000	\$492,000
Licensed Boiler Operators	4	\$ 30.00	\$240,000	\$295,200
Utilities	4	\$ 15.00	\$120,000	\$147,600
WDGS Operators	4	\$ 20.00	\$160,000	\$196,800
WWT operators	1	\$ 20.00	\$40,000	\$49,200
Maintenance Supervisor	1	\$ 45.00	\$90,000	\$110,700
Mechanical	4	\$ 30.00	\$240,000	\$295,200
Welders	4	\$ 30.00	\$240,000	\$295,200
Electrical	4	\$ 30.00	\$240,000	\$295,200
Utilities	4	\$ 20.00	\$160,000	\$196,800
Totals	78	\$ 26.83	\$4,185,000	\$5,147,550

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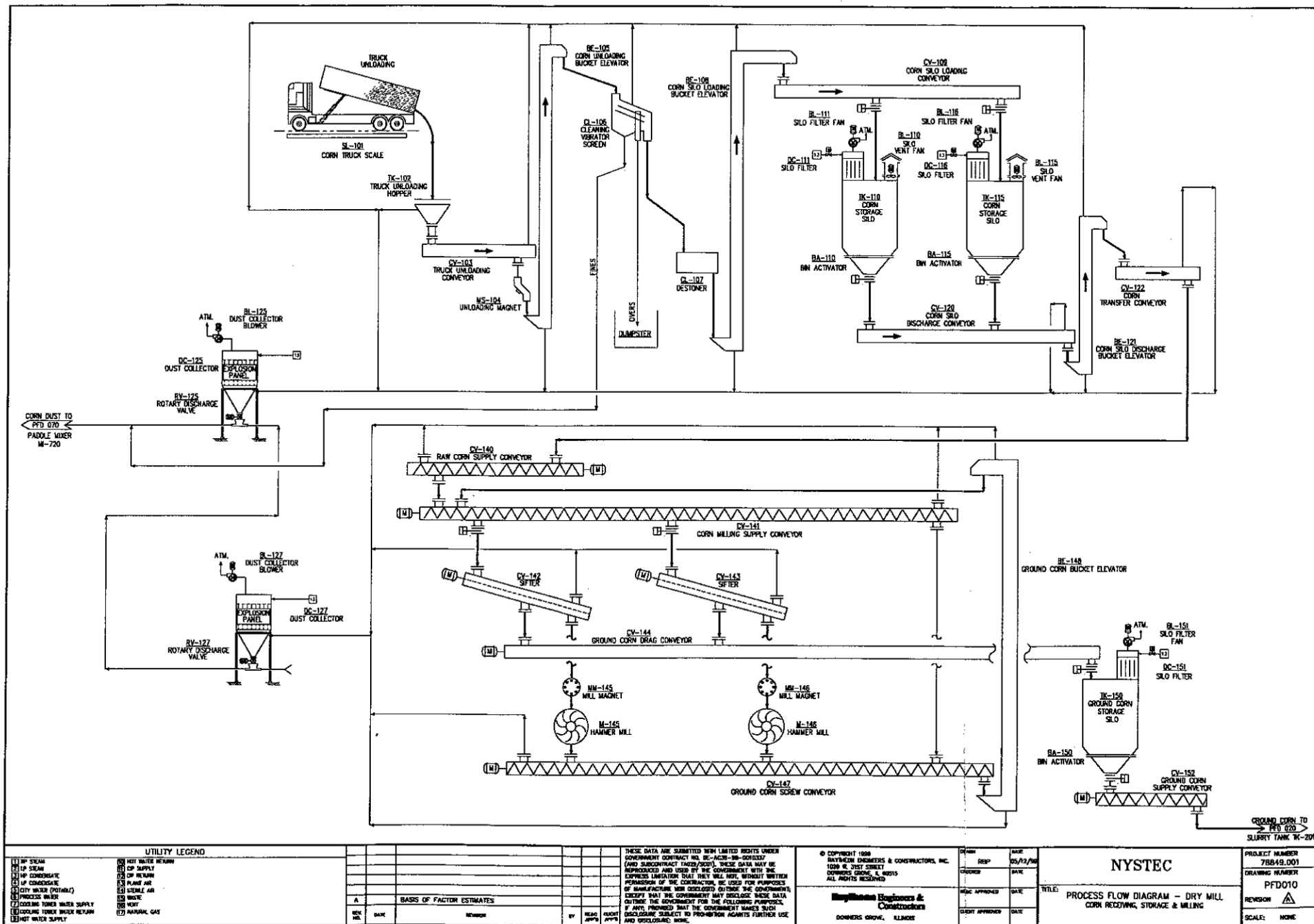
Building a Bridge to the Corn Ethanol Industry

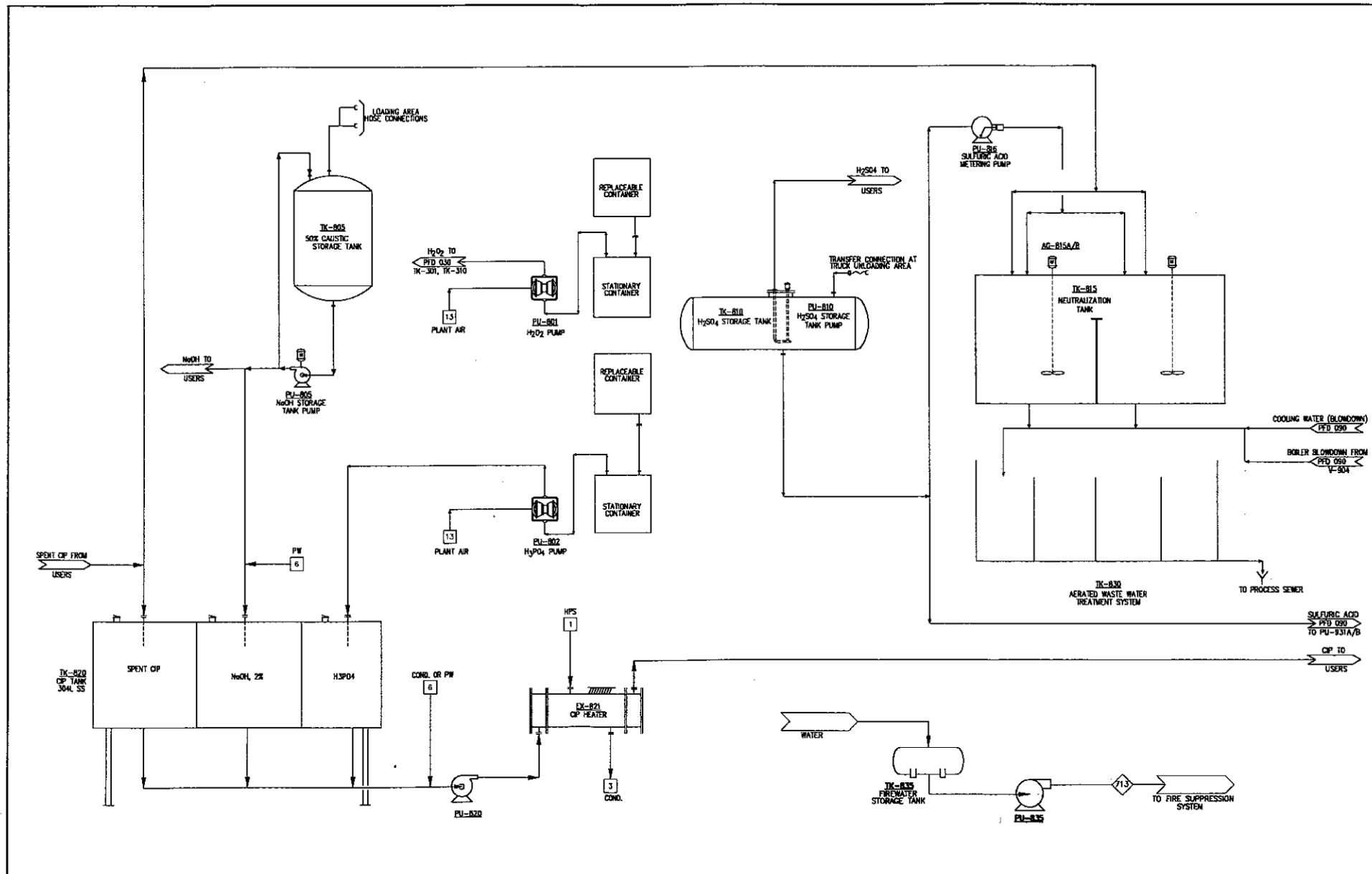


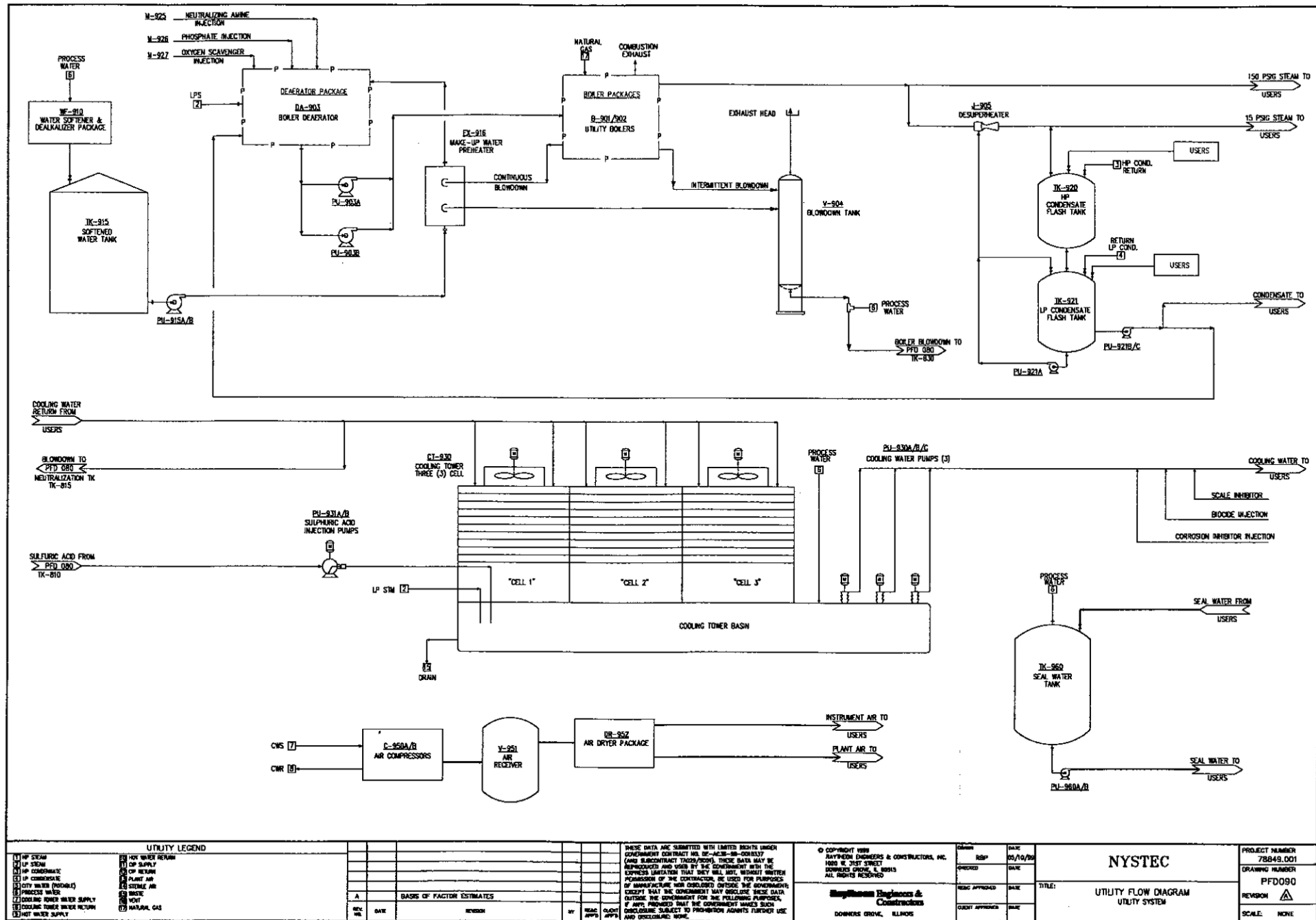
F. PROCESS FLOW DIAGRAMS

These are the related process flow diagrams. Physical depictions of process equipment are not necessarily accurately represented.

- PFD010 – Corn Receiving, Storage, & Milling
- PFD020 – Liquefaction & Saccharification
- PFD030 – Fermentation
- PFD040 – Distillation
- PFD050 – Stillage Decanters
- PFD060 – Evaporation
- PFD070 – Product Storage System
- PFD080 – Storage Tanks, CIP, & Neutralization System
- PFD090 – Utility System







**Feedstock Production Quantities
1993-1998 Average Yield (tons)
Priority Listing**

Feedstock Type	Priority	RCBS	North Country Region	New York State
Corn Stover	1A	1,339	49,720	1,208,000
Grass	1B	750	354,740	1,848,000
Straw	1C	212	2,978	294,740
Papermill Residue	1D	0	151,000	643,000
Corn	1E	1,962	69,185	1,859,200
Corn Silage	2	1,246	1,202,420	7,779,200
Cheese Whey	4	0	74,179	219,853
Brewery Solids	3	0	0	2,901,690
Vegetable Wastes				
Beets	7	0	0	17,045
Cabbage	6	0	0	19,240
Carrots	11	0	0	8,218
Peas	12	0	0	3,767
Snap Beans	8	0	0	14,281
Sweet Corn	5	0	0	149,856
Fruit Pomace				
Apples	10	0	0	46,132
Cherries	14	0	0	1283
Grapes	9	0	0	77,195
Winery Waste	13	0	0	18,853
Willow Biomass	15	0	0	230

The quantity for all the vegetable feed stocks may need to be adjusted for quality. Having some experience at a particular vegetable-handling factory that produced frozen vegetables for packaging, the amount of sweet corn waste needs to be categorized. I have seen culls for grease contamination before processing, which I suspect occurs at these facilities also. These culls cannot be used in the ethanol plant because of the grease contamination that would occur. I believe that the "clean" shuckings and cobs are processable.

June 3, 1999

Ms. Anne Hartman
NYSTEC
75 Electronic Parkway, Suite 2
Rome, NY 13441-4505

Subject: Feedstock Analysis
Project No. 78849.001

Dear Ms. Hartman:

The feedstock analysis sheets have been studied and considered for incorporation into an alcohol plant(s). Attached are summary analysis sheets for potential State Wide, North Country, and Ron Robbins farm alcohol production. Current analysis suggests:

- Ron Robbins farm is not a large enough raw material supplier for its own plant
- The North Country (as currently defined) may be a large enough raw material supplier for a plant. It could be made more viable by including several other counties.
- Corn stover, grass, straw, and corn appear to be very viable feedstocks, probably for up to 4 plants of 50-60 million gallons.

A discussion about all feedstocks follows:

Corn Stover, Grass, Straw

The corn stover, grass and straw will be discussed as one group since they can be handled similarly for plant feed stock. They require a minimum double size reduction for input to the process. These materials were initially considered as baled units for input to the plant. However, material handling analysis suggests that the best way to bring these materials to the plant are in a pulverized bulk state of 2 to 4 inch pieces, or smaller. This makes it easier to handle and surge. The pulverized bulk state of 2 to 4 inch pieces would be further reduced at the plant to less than $\frac{3}{4}$ inch size for surge storage and process input. The surge storage would consist of a flat slab and reclaimer with weather protection. The basis of the 2 to 4 inch pieces are pulverizing using a tub grinder, or feed cutter, probably already in use on the farm to process bales, at the farm to fill standard semi-trailers for delivery to the plant.

Corn

Corn is the easiest material to handle because of current commercialization. However, the production volume seemed high. The corn rate was adjusted to the surplus grain quantity produced in 1997 according to New York Agricultural Statistics. The rate was then increased by 15% assuming that the DDGS produced would replace an equal amount of corn currently used in animal feed. The plan sizing basis was increased an additional 25% to 30MM gallons of ethanol per year to allow for some immediate growth in corn supply and for equipment optimizations.

Corn Silage

Corn silage was not considered. It is probably only grown for dairy cow feed and supplies the demand. Storage and handling characteristics favor dry bulk solids. This also increases the wastewater handling requirements because of the water content.

Sweet Corn

Utilization of sweet corn residue increases the wastewater flow rate an estimated 50% for a short period (assumed 3 months). A possible fee to support the increase size of the waste treatment plant has poor economics for the amount of utilization. Additionally, the waste treatment plant would be very hard to operate for 9 months of the year with that much extra capacity.

Brewery Solids

The availability of brewery solids is suspect. They probably already dispose of the solids in an efficient economical method. However, if they do not, they should be able to support their own plant for the potential quantity of alcohol.

Papermill Residue

The papermill residue needs additional information to determine whether it is attractive or sufficiently available for feedstock. The data sheet denotes 263,000 tons per year of the 643,000 tons per year produced being taken by the industrial stoker coal market. This portion of the materials may be the lower ash content portions, which are the same desirable materials for the ethanol plant. The high ash deinking mill stock is not desirable because of higher ion exchange and overliming capacity requirements, and higher fouling rates for the boiler burning the waste solids. Quantities of bark and woodchips would be desirable.

Other Feedstocks

The other feedstocks; cabbage, beets, beans, grapes, apples, carrots, peas, wine waste, and cherries, are not attractive for the relatively small amounts of alcohol produced and the large amounts of wastewater. Apples have an additional problem because of the pectin content (a thickening agent). This would increase the pump motor horsepower. The fruits; grapes, apples, and cherries, also would probably need to be pasteurized to reduce the formation of acetic acid from fermentation before loading into a truck for transportation to the plant. Higher acetic acid content would increase the ion exchange and overliming system sizes. These unattractive feedstocks could become attractive with an appropriate fee structure.

We are proceeding on the basis of a plant based on corn stover, grass, and straw, as well as a plant based on corn grain.

Sincerely,

James E. Cole
Project Manager

cc: Gail Luttinen

NYSTEC
PROJECT NO. 78849.001
TRIP REPORT NO. 1

TRIP DATE: March 10, 1999

DATE: May 4, 1999

LOCATION: Ron Robbins Farm - Kitchen

Attendees:	<u>RE&C</u>	<u>NYCGA</u>	<u>NYSTEC</u>	<u>PIONEER</u>
	J. Cole	Jim Czub	Anne Hartman	Keith Culver
	G. Luttinen	Ron Robbins		
	S. Newberg			

There was general discussion about the project and opportunities. The NYCG Association has a 5 year goal to develop an alcohol plant or some other additional opportunity to expand economic horizon for farm products. An alcohol plant may be in the range of 15MM gal/year.

Corn grain crop production is now 108% of farmers needs for dairy and live stock feeds. Hay and straw are now baled in 3x3x8 foot bales, which can contain small quantities of small stones.

Robbins Corn & Bulk Services grain processing facility is located on South Harbor road (a county highway) Sacketts Harbor, NY. The following observations were made

- Nearest natural gas service - 1.8 miles west on South Harbor Road at small store.
- Nearest 3 phase electrical - 0.7 miles for farm power service.
- Nearest community water service - 1.5 miles to small water tower and main.
- Well water at 50 to 250 feet.
- 2 miles to Lake Ontario
- Topsoil generally 1 to 4.5 feet thick over limestone bedrock.
- Major power substations:
 - North Watertown - 10 miles as crow flies
 - Adams - 7 miles as crow flies
- Rail service by Conrail about 7 miles in Adams at Agway, runs north-south.
- No barge facilities remain in Sacketts Harbor
- Wes Alcombrak zoning official, 315-788-2777
- Niagara Mohawk Electric Power Company

Wet DDGS has a useful "shelf-life" of 5 to 20 days for animal feed according to Ron Robbins experience. DDGS has previously been obtained in 25-ton loads.

Post meeting follow-up: there is a potential for 200,000 t/yr of DDGS usage by the dairy industry.

Jim Czub
NYCGA Corn Board Liaison NY
141 Verbeck Ave.
Schaghticoke, NY 12154
518-753-7795 (P)
518-753-0059 (F)

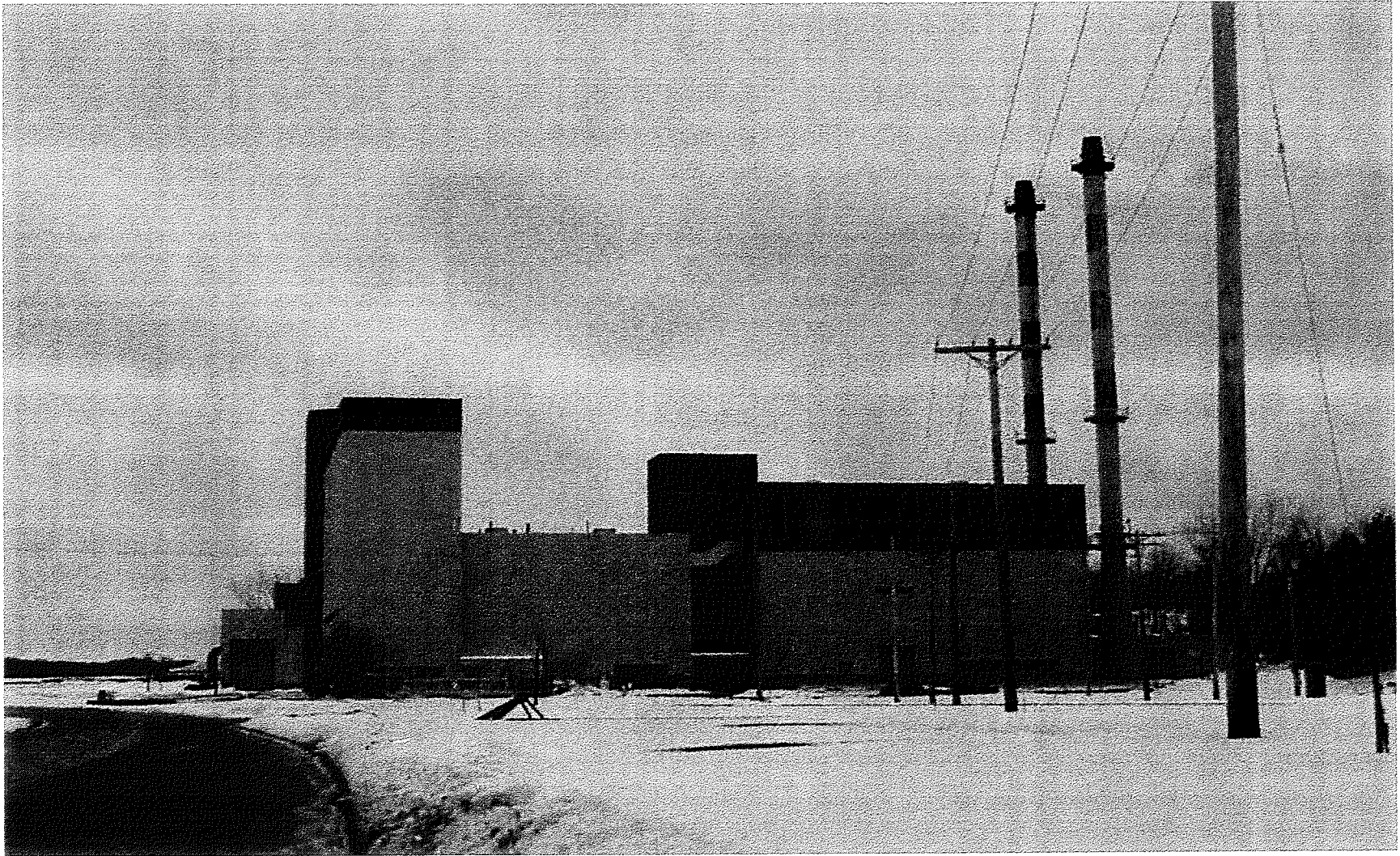
Ron Robbins
President NYCGA
14471 County Rt. 145
Sacketts Harbor, NY 13685
315-583-5016 (P)
315-583-6483 (F)

Keith Culver
RD #1 Box 184
Auburn, NY 13021
315-364-6750 (P)
315-252-6100 (F)

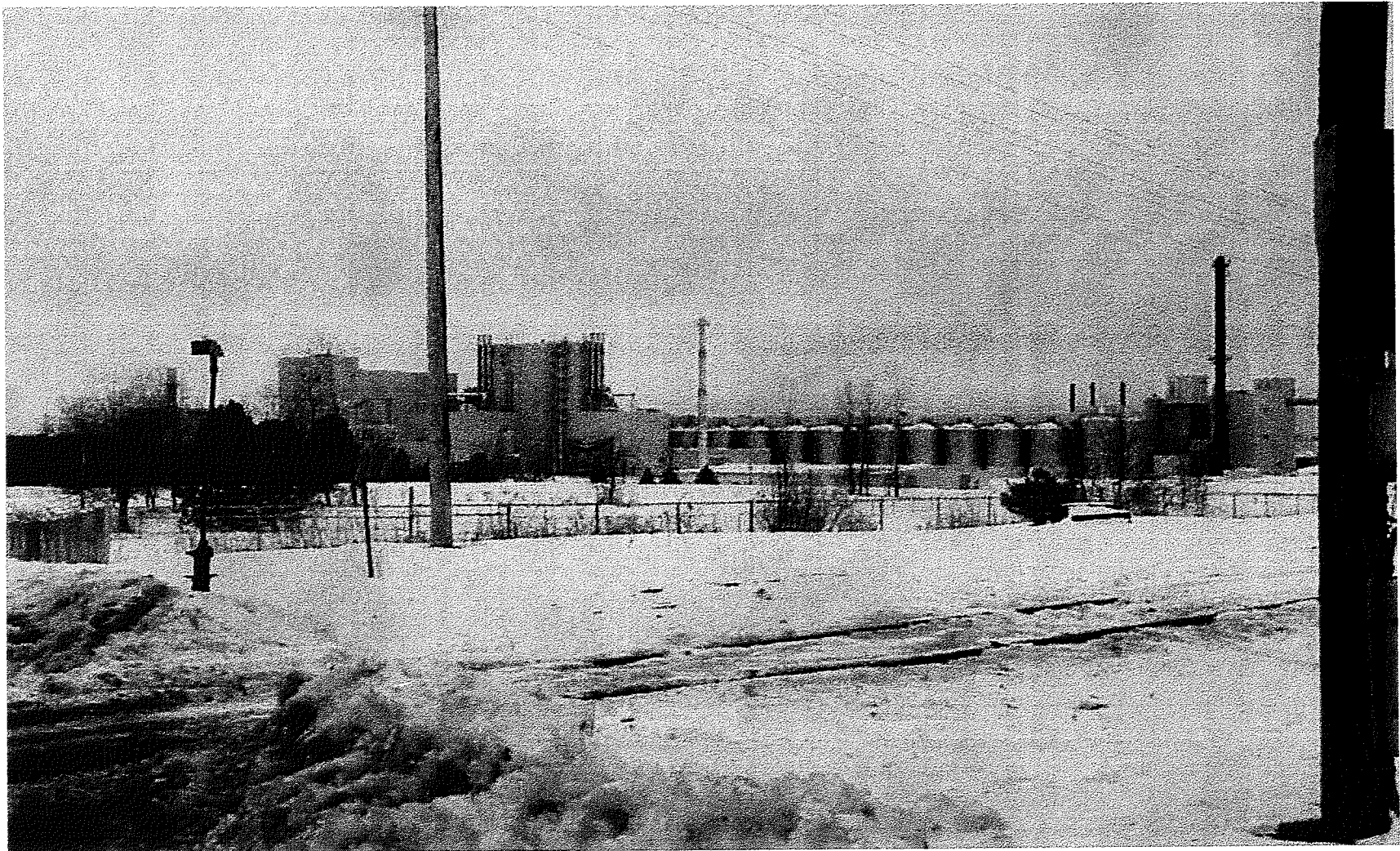
ROBBINS CORN AND BULK SERVICE



GRIFFISS AFB BOILER



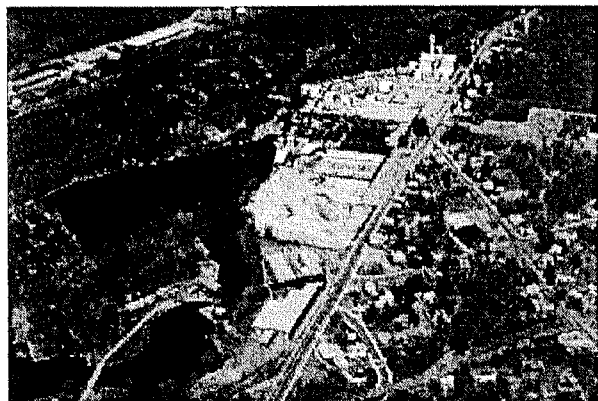
MILLER BREWERY FULTON, NEW YORK



MILLER BREWERY FULTON, NEW YORK



Carthage Paper Mill Site



Links to Information on Jefferson County
Northern New York Regional Profile
County Job Development Corporation
Jefferson County Industrial Development Agency
Greater Watertown Chamber of Commerce

Village of

Carthage, Jefferson County, New York

Site Features (Click here to view full page photo)

- 66 Acres Available (22 seperate buildings)
- Industrial Zoning
- Buildings contain a total of 224,000 sq. ft. of production and warehouse space
- Electric provided by Niagara Mohawk <http://www.nimo.com>
- Natural gas supplied by Niagara Mohawk <http://www.nimo.com>
- Water provided by the City of Watertown
- Wastewater treatment services provided by the City of Watertown

Note: This facility was used as a paper producing and converting mill less than 1 year ago. The site will soon be controlled by the Jefferson County Industrial Development Agency and will be available at terms well below market rates.

[Return to Home](#)

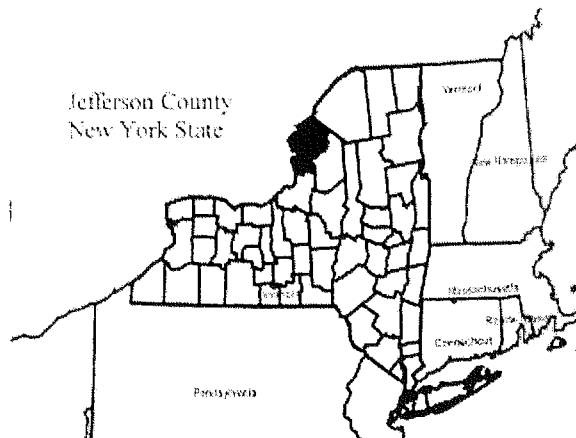
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Contact Us At:

Niagara Mohawk
Economic & Community Development
300 Erie Boulevard West
Syracuse, NY 13202
800-944-6460
email at carthage@shovelready.com



Appendix D

Baseline Pro-Forma

Capital and Site Review

Cost At Startup	
Improvements to Site	\$1,264,000
Earthwork	\$4,108,000
Concrete	\$10,113,000
Structural Steel	\$6,687,000
Process Equipment	\$63,206,000
Piping	\$29,075,000
Insulation	\$3,792,000
Instrumentation & Controls	\$18,962,000
Electrical	\$10,745,000
Painting	\$1,896,000
Building & Architectural	\$9,481,000
Direct Field Cost	\$159,329,000
Start-up, Testing & Training	Excluded
Temporary Facilities	Included Above
Construction Equipment, Tools, Supplies	Included Above
Field Staff and Legalities	\$4,677,000
Indirect Field Cost	\$4,677,000
Total Field Cost	\$164,006,000
Engineering	\$13,906,000
Total Field and Home Office	\$177,912,000
Taxes	\$0
Insurance	\$1,011,296
Permits	\$94,809
Craft Causal Overtime	\$506,000
Contingency	\$46,140,000
Escalation	\$0
Subtotal	\$225,664,105
CM Fee	\$4,680,000
Total	\$230,344,105

		Debt Schedule																					
		Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Long-term debt																							
<div> <div> <div>A</div> <div>Term (Years): 15</div> </div> <div> <div>Cost of Capital and Bk Work:</div> <div>\$230,344,105</div> </div> <div> <div>Up-Front Payment:</div> <div>\$0</div> </div> <div> <div>Working Capital:</div> <div>\$25,034,411</div> </div> <div> <div>Original Balance:</div> <div>\$253,378,518</div> </div> <div> <div>Salvage Price:</div> <div>\$0</div> </div> </div> <div> <div>Debt / Equity Ratio:</div> <div>n/a</div> </div>	Debt Balance:	\$90,595,855	\$140,370,873	\$253,378,518	\$246,014,008	\$237,839,405	\$228,785,596	\$218,693,667	\$207,513,827	\$195,104,204	\$181,329,622	\$166,099,626	\$149,067,941	\$130,229,159	\$109,319,223	\$86,107,083	\$60,342,719	\$31,744,274	\$0	\$0	\$0	\$0	\$0
	Interest Rate above inflation(%):	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%
	Interest Paid:	\$6,665,555	\$15,440,796	\$27,871,637	\$27,061,541	\$26,162,335	\$25,164,218	\$24,064,309	\$22,869,521	\$21,461,462	\$19,948,247	\$18,264,359	\$16,397,482	\$14,325,208	\$12,026,005	\$9,471,779	\$6,637,090	\$3,491,870	\$0	\$0	\$0	\$0	\$0
	Principal Paid:	(\$6,665,555)	\$0	\$7,364,507	\$6,174,003	\$6,073,809	\$10,071,828	\$11,179,841	\$12,409,823	\$13,774,682	\$15,239,896	\$16,971,705	\$18,938,681	\$20,810,938	\$23,211,130	\$25,764,365	\$28,066,445	\$31,744,274	(\$0)	(\$0)	(\$0)	(\$0)	(\$0)
	Additional Principal Paid:																						
	Sub-Total Payment:	\$0	\$15,440,796	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$35,236,144	\$0	\$0	\$0	\$0	\$0
	Amortization of Loan Fees:	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$236,487	\$0	\$0	\$0	\$0	\$0
	Total Payment:	\$236,487	\$15,677,283	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$35,472,631	\$0	\$0	\$0	\$0	\$0
	Int'l depr. Exp.																						
	Long-term Debt Summary																						
		Operating Balance:	\$90,595,855	\$140,370,873	\$253,378,518	\$246,014,008	\$237,839,405	\$228,785,596	\$218,693,667	\$207,513,827	\$195,104,204	\$181,329,622	\$166,099,626	\$149,067,941	\$130,229,159	\$109,319,223	\$86,107,083	\$60,342,719	\$31,744,274	\$0	\$0	\$0	\$0
		Total Interest Paid:	\$6,665,555	\$15,440,796	\$27,871,637	\$27,061,541	\$26,162,335	\$25,164,218	\$24,064,309	\$22,869,521	\$21,461,462	\$19,948,247	\$18,264,359	\$16,397,482	\$14,325,208	\$12,026,005	\$9,471,779	\$6,637,090	\$3,491,870	\$0	\$0	\$0	\$0
		Total Principal Paid:	(\$6,665,555)	\$0	\$7,364,507	\$6,174,003	\$6,073,809	\$10,071,828	\$11,179,841	\$12,409,823	\$13,774,682	\$15,239,896	\$16,971,705	\$18,938,681	\$20,810,938	\$23,211,130	\$25,764,365	\$28,066,445	\$31,744,274	(\$0)	(\$0)	(\$0)	(\$0)
		Additional Principal Paid:				\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
		Total Payments:	\$0	\$15,440,79																			

Annual Materials Costs	
1990	1991
1992	1993
1994	1995
1996	1997
1998	1999
2000	2001
2002	2003
2004	2005
2006	2007
2008	2009
2010	2011
2012	2013
2014	2015
2016	2017
2018	2019
2020	2021
2022	2023
2024	2025
2026	2027
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2100	2101
2102	2103
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2108	2109
2110	2111
2112	2113
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2118	2119
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2144	2145
2146	2147
2148	2149
2150	2151
2152	2153
2154	2155
2156	2157
2158	2159
2160	2161
2162	2163
2164	2165
2166	2167
2168	2169
2170	2171
2172	2173
2174	2175
2176	2177
2178	2179
2180	2181
2182	2183
2184	2185
2186	2187
2188	2189
2190	2191
2192	2193
2194	2195
2196	2197
2198	2199
2200	2201
2202	2203
2204	2205
2206	2207
2208	2209
2210	2211
2212	2213
2214	2215
2216	2217
2218	2219
2220	2221
2222	2223
2224	2225
2226	2227
2228	2229
2230	2231
2232	2233
2234	2235
2236	2237
2238	2239
2240	2241
2242	2243
2244	2245
2246	2247
2248	2249
2250	2251
2252	2253
2254	2255
2256	2257
2258	2259
2260	2261
2262	2263
2264	2265
2266	2267
2268	2269
2270	2271
2272	2273
2274	2275
2276	2277
2278	2279
2280	2281
2282	2283
2284	2285
2286	2287
2288	2289
2290	

			Amount	Unit	Cost	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 16	Year 18	Year 17	Year 18	Year 19	Year 20	
Feedstock																												
	Biomass	840,000 tons/year	\$35.00		\$0	\$14,700,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	\$29,400,000	
Operating Chemicals																												
	H2SO4	4,170 pounds/hr	\$0.03		\$0	\$455,364	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	\$910,728	
	Lime	1,764 pounds/hr	\$0.04		\$0	\$277,830	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	\$555,660	
	NH3	1,530 pounds/hr	\$0.11		\$0	\$674,730	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	\$1,349,460	
	CSL	2 tons/hr	\$25.00		\$0	\$217,455	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	\$434,910	
	Nutrients	383 pounds/hr	\$0.12		\$0	\$199,466	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	\$398,933	
	NH4SO4	863 pounds/hr	\$0.02		\$0	\$81,564	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	\$163,107	
	Antifoam	12 pounds/hr	\$0.24		\$0	\$12,096	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	\$24,192	
	Gasoline	369 gal/hr	\$0.60		\$0	\$829,890	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	\$1,659,780	
	BFW Chemicals	2 pounds/hr	\$0.97		\$0	\$9,963	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	\$17,926	
	CW Chemicals	11 pounds/hr	\$1.00		\$0	\$46,200	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	\$92,400	
	WWT Nutrients	495 pounds/hr	\$0.11		\$0	\$228,690	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	\$457,380	
	WWT Chemicals	2 pounds/hr	\$2.50		\$0	\$17,116	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	\$34,230	
	NAOH	110 pounds/hr	\$0.17		\$0	\$76,230	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	\$152,460	
	H3PO4	22 pounds/hr	\$0.37		\$0	\$34,188	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	\$68,376	
	H2O2	44 pounds/hr	\$0.50		\$0	\$91,478	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	\$182,952	
	Cellulase	750 pounds/yr	\$150.00		\$0	\$56,250	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	
	Cellulase	750 pounds/yr	\$150.00		\$0	\$56,250	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	\$112,500	
Process Water																												
	Water				\$0	\$723,196	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	\$1,446,396	
Natural Gas																												
	Natural Gas	100 therms/hr	\$1.86		\$0	\$781,200	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	\$1,562,400	
Disposal Costs																												
	Landfill	3,735 pounds/hr	\$0.01		\$0	\$158,870	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	\$313,740	
Maintenance Materials																												
	Maintenance Materials				\$0	\$983,100	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	\$1,966,200	
	Lubricants				\$0	\$50,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	
	Laboratory Chemicals				\$0	\$48,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	\$96,000	
Miscellaneous Incidentals																												
	Operating Supplies				\$0	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	\$445,000	
Total Cost						\$0	\$21,306,106	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209	\$42,167,209

Employee Forecast																						
	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Production																						
Number of Employees:	0	42.7	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	
Avg. Salary/Wage per Employee:	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	\$50,103	
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	
Employer Contribution (\$):	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	\$11,524	
Per Employee Total:	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	\$61,627	
Production Salary/Wage Total:	\$0	\$2,138,400	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	\$4,860,000	
Employer Contribution Total:	\$0	\$491,832	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	\$1,117,800	
Department Total:	\$0	\$2,630,232	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	\$5,977,800	
General & Administrative																						
Number of Employees:	0	3.1	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	
Avg. Salary/Wage per Employee:	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	\$65,000	
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	
Employer Contribution (\$):	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	\$14,950	
Per Employee Total:	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	\$79,950	
General & Administrative Salary/Wage Total:	\$0	\$200,200	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	\$455,000	
Employer Contribution Total:	\$0	\$46,046	\$104,650	\$104,650	\$																	

Revenue Forecast

[illegible]

Tax Impacts	
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[illegible]

Income Statement

[illegible]

Income / Expenses in Actual Year Dollars

Discount Factor:	1.00	1.00	1.00	0.97	0.94	0.92	0.89	0.86	0.84	0.81	0.79	0.77	0.74	0.72	0.70	0.68	0.66	0.64	0.62	0.61	0.59	0.57
Total Income																						
Sales of Ethanol and Co-Products	\$0	\$50,573,375	\$75,870,778	\$75,880,901	\$78,157,358	\$80,502,048	\$82,817,110	\$85,404,823	\$87,884,782	\$90,605,785	\$93,523,957	\$96,123,698	\$98,007,395	\$101,877,585	\$105,036,914	\$108,185,021	\$111,433,862	\$114,776,872	\$118,819.972	\$121,785.571	\$125,419,508	\$129,182,155
Total	\$0	\$50,573,375	\$75,870,778	\$75,880,901	\$78,157,358	\$80,502,048	\$82,817,110	\$85,404,823	\$87,884,782	\$90,605,785	\$93,523,957	\$96,123,698	\$98,007,395	\$101,877,585	\$105,036,914	\$108,185,021	\$111,433,862	\$114,776,872	\$118,819.972	\$121,785.571	\$125,419,508	\$129,182,155
Total Expenses																						
Feedstock	\$0	\$14,700,000	\$28,400,000	\$29,282,000	\$31,190,400	\$32,135,174	\$33,090,659	\$34,052,656	\$35,105,159	\$36,158,252	\$37,333,040	\$38,326,002	\$39,511,142	\$40,598,470	\$41,917,270	\$43,174,281	\$44,470,159	\$45,804,942	\$47,173,599	\$48,585,720	\$50,055,532	\$51,585,078
Operating Chemicals	\$0	\$6,493,377	\$9,827,479	\$7,593,299	\$7,596,957	\$7,798,025	\$7,798,025	\$8,090,840	\$8,271,708	\$8,519,918	\$8,795,032	\$9,008,782	\$9,308,945	\$9,599,243	\$10,175,425	\$10,478,425	\$10,782,778	\$11,116,561	\$11,450,098	\$11,798,880	\$12,147,987	\$12,507,267
Process Water	\$0	\$729,158	\$1,446,968	\$1,458,788	\$1,834,482	\$1,580,518	\$1,827,281	\$1,777,855	\$1,727,072	\$1,779,855	\$1,987,214	\$1,943,835	\$2,002,155	\$2,052,215	\$2,124,061	\$2,187,804	\$2,258,458	\$2,327,104	\$2,390,672	\$2,452,982	\$2,586,284	\$2,686,284
Natural Gas	\$0	\$781,800	\$1,052,400	\$1,028,272	\$1,057,550	\$1,170,277	\$1,178,445	\$1,211,620	\$1,250,597	\$1,281,555	\$1,479,302	\$1,088,578	\$2,088,735	\$2,162,727	\$2,227,009	\$2,294,457	\$2,365,870	\$2,454,188	\$2,507,188	\$2,582,408	\$2,659,881	\$2,730,678
Disposal Costs	\$0	\$158,000	\$153,740	\$205,105	\$153,740	\$450,882	\$355,117	\$355,117	\$355,117	\$355,117	\$357,435	\$404,590	\$414,280	\$444,510	\$447,318	\$460,738	\$474,590	\$488,707	\$505,491	\$518,084	\$534,125	\$550,145
Performance Materials	\$0	\$1,058,100	\$1,058,100	\$1,058,100	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200
Miscellaneous Materials	\$0	\$440,000	\$440,000	\$440,000	\$442,101	\$440,344	\$500,851	\$516,877	\$521,305	\$467,304	\$505,719	\$500,824	\$398,045	\$115,994	\$554,458	\$553,458	\$575,102	\$569,259	\$714,024	\$725,517	\$757,553	\$750,510
Salaries / Wages	\$0	\$2,876,478	\$6,557,450	\$8,733,575	\$6,585,540	\$7,143,448	\$7,357,257	\$7,578,860	\$7,308,057	\$8,040,238	\$8,281,448	\$8,829,589	\$8,736,785	\$9,048,359	\$9,280,840	\$9,400,485	\$9,886,470	\$10,185,134	\$10,440,688	\$10,805,408	\$11,130,070	\$11,485,458
Depreciation	\$0	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483
Interest Expense	\$0	\$16,440,746	\$27,871,857	\$27,081,541	\$28,182,930	\$28,104,216	\$28,008,500	\$22,869,521	\$21,461,492	\$19,849,347	\$18,384,598	\$16,387,482	\$14,326,000	\$12,025,005	\$9,471,779	\$6,697,090	\$3,491,870	\$0	\$0	\$0	\$0	\$0
Amortization of Loan Fee	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467	\$208,467
Performance Materials	\$0	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200	\$2,185,200
Amortization of Start-up Expenses	\$0	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594	\$1,269,594
Total	\$208,467	\$55,700,997	\$92,744,014	\$88,475,072	\$94,157,133	\$96,747,984	\$98,977,984	\$101,844,814	\$104,420,357	\$107,005,890	\$109,620,364	\$112,273,519	\$114,968,505	\$117,710,519	\$120,503,005	\$123,346,005	\$126,239,005	\$129,182,144	\$132,182,144	\$135,239,005	\$138,354,505	\$141,529,505
Pre-Tax Profit	(\$208,467)	(\$28,219,724)	(\$19,075,236)	(\$17,594,171)	(\$15,996,806)	(\$14,287,752)	(\$13,000,464)	(\$10,735,289)	(\$9,826,053)	(\$4,800,378)	(\$2,040,719)	\$19,675	\$5,070,008	\$8,774,622	\$10,250,985	\$14,399,457	\$18,425,585	\$22,935,262	\$28,081,747	\$38,174,064	\$50,339,239	
Income Taxes	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
State Tax, Sales Tax, Property Tax	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$10,435	\$10,748	\$11,008	\$11,740	\$12,008	\$12,652	\$13,517	\$14,619	\$15,915	\$17,442	\$19,208	\$21,222	\$23,496	\$26,032	\$28,852
Pre-Tax After Taxes	(\$208,467)	(\$28,219,724)	(\$19,075,236)	(\$17,594,171)	(\$15,996,806)	(\$14,287,752)	(\$13,000,464)	(\$10,735,289)	(\$9,826,053)	(\$4,800,378)	(\$2,040,719)	\$19,675	\$5,070,008	\$8,774,622	\$10,250,985	\$14,399,457	\$18,425,585	\$22,935,262	\$28,081,747	\$38,174,064	\$50,339,239	

Value of Assets at Year End in Individual Year Dollars.

Fixed Assets																						
Plant and Equipment	\$100,561,610	\$140,570,679	\$228,294,177	\$216,278,094	\$204,285,211	\$192,247,726	\$180,282,245	\$168,216,782	\$156,201,279	\$144,185,786	\$132,170,319	\$120,154,890	\$108,139,547	\$96,128,064	\$84,108,381	\$72,092,598	\$60,077,415	\$48,061,952	\$36,046,448	\$24,030,995	\$12,015,483	\$0
Less Accumulated Depreciation	\$0	\$12,015,483	\$20,155,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$12,015,483	\$0
Other	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Long-term Assets	\$100,561,610	\$128,555,196	\$208,138,694	\$204,262,611	\$192,247,726	\$168,232,245	\$168,232,245	\$156,201,279	\$144,185,786	\$132,170,319	\$120,154,890	\$108,139,547	\$96,128,064	\$84,108,381	\$72,092,598	\$60,077,415	\$48,061,952	\$36,046,448	\$24,030,995	\$12,015,483	\$0	\$0

Next Present Value Analysis

[illegible]

First Year Cost-per-Gallon Analysis

Expense Category	Year One Cost	Cost per Gallon
Fuelstock	\$29,400,000	\$0.460
Operating Chemicals	\$6,327,479	\$0.108
Process Water	\$1,448,988	\$0.023
Natural Gas	\$1,662,400	\$0.024
Disposal Costs	\$515,740	\$0.005
Maintenance Materials	\$2,079,230	\$0.032
Miscellaneous Incidentals	\$445,000	\$0.007
Salaries / Wages	\$6,207,490	\$0.102
Depreciation	\$12,015,488	\$0.186
Interest Expense	\$27,871,857	\$0.439
Amortization of Loan Fees	\$236,467	\$0.004
Insurance	\$2,533,795	\$0.040
Amortization of Start-up Expenses	\$1,265,894	\$0.020
Profit	\$19,075,325	\$0.299
Total	\$73,874,778	\$1.180

Summary of Transportation Costs

[illegible]